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NOTES ON THE GAMETOPHYTES AND EMBRYO OF PODOCARPUS.

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(WITH PLATES V–VII)

DURING a visit to Jamaica in the summer of 1900 I took advantage of the opportunity to make a collection of female cones of *Podocarpus coriacea* from trees cultivated in Castleton Garden. The climate of this part of the island, hot and wet, is apparently not congenial to this species, for it was afterward found that none of the ovules had been pollinated. This absence of pollen tubes, in connection with the fact that it was necessary to fix in alcohol, made the material of little value, and only a few of the figures are drawn from it.

Most of the results were obtained from collections made in June and July, 1901, from a male and a female tree grown in Darlington, South Carolina. The plants were small and scraggy, but both bore numerous cones, and, though they were separated by more than a hundred feet, over 95 per cent. of the ovules examined were furnished with pollen tubes. I cannot state positively that these trees are also *P. coriacea*, as there was no means of identifying them at the time, and I neglected to bring the vegetative parts to this country. However, as the fruits seem identical with those collected in Jamaica, it is probable that they are the same species.

It is unfortunate that the results here given are not more

complete, and they are published with the hope of supplementing them from future collections. The Darlington material was fixed at the tree in corrosive-acetic (aqueous solution of corrosive sublimate 95 parts, glacial acetic acid 5 parts), the prothallium being exposed at the sides or removed with the nucellus from the integuments. Sections 5 or 10 μ in thickness were made in paraffin, and in the case of the pollen stained in Haidenhain's iron-alum-haematoxylin or Flemming's triple. For prothallium and archegonium the latter stain was most used; while with embryos a combination of Delafield's haematoxylin and saffranin gave the best results.

Most of the work has been done in the Bonn laboratory, and I wish to express here my appreciation of the unfailing kindness of Professor Strasburger.

THE POLLEN SAC AND POLLEN GRAIN.

Two pollen sacs are borne on the lower surface of each sporophyll, as in the Abieteae, but they differ from these in being less sunken in the tissue and in their wider separation. The wall of the mature sac (*fig. 11*) consists of an outer layer of large cells whose walls are strengthened internally with thickened bands, and of three or four layers of thin cells which finally almost completely collapse. Within these is the one-layered tapetum, which disorganizes during the time that the pollen grains are undergoing their divisions. In *fig. 11* some of the tapetal cells are shown to contain two nuclei, which is often the case. It will be noticed that the microsporangium wall as here described is very like that of the Abieteae, while it differs from the generally two-layered wall found in the Cupresseae and Taxodium.[1]

In the development of the pollen the youngest stage found was after the separation of the tetrads, and before the first division of the grain. The wings have already reached their full size. All stages, from the uninucleate to the completely mature

[1] All references to Taxodium, unless otherwise stated, are taken from my unpublished paper on the gametophyte and embryo of Taxodium, a short preliminary account of which appeared in the *Johns Hopkins University Circular* 19:—. 1900.

pollen grain, were found in material collected from the same tree on a single day. This does not necessarily imply any unusual rapidity of development, for pollen was being shed from this tree for more than a week. As a matter of fact, however, the divisions in the grain, when once begun, follow each other in rapid succession, a fact also noted in the pollen of Pinus by Coulter and Chamberlain (1901). In the same cone undivided grains may be found at the top and three-celled ones at the base. It may be stated at once that there are three mitotic divisions in the pollen grain, forming two prothallial cells, a generative cell, and a tube nucleus. This noteworthy and rather unexpected behavior shows that in all essential points the pollen grains of Podocarpus and of the Abieteae are duplicates, and the peculiarities to be described below do not affect this fundamental agreement.

It is interesting to note here a prediction made by Schacht as long ago as 1860. He says: "Podocarpus, dessen männliche Blüthe den Abietineen entspricht, hat auch dieselbe Form des Blüthenstaubs, der wahrschleinlich in derselben Weise seinen Pollenschlauch entwickelt." The only other gymnosperm in which it is established that two prothallial cells are normally found in the pollen grain is Ginkgo, first figured by Schacht (1860). In *Ceratozamia longifolia* Jurányi (1870) found three small cells (presumably two prothallial and one generative) sometimes present in the pollen grain, although two was the commoner number. In all other Cycadales investigated only one prothallial cell has been found. Schacht found three small cells in the pollen of Ephedra, while Jurányi (1882) figures a varying number, in one case six nuclei being shown. In Taxus and the Cupresseae no prothallial cell has yet been discovered in the microspore, and there are none found in Taxodium.

During all of its divisions the pollen grain of Podocarpus is packed with starch (*figs. 1–6*), which disappears only just before the grain is shed. I know of no other gymnosperm in which this is the case. The first division is shown in *fig. 1*. A prothallial cell of the usual shape is cut off, but, as in other cases,

no cellulose wall is formed. The second division follows promptly, cutting off a similar cell (*fig. 2*), and a third gives rise to the generative cell and the tube nucleus (*fig. 3*). The spindles of all the divisions are much broader at the prothallial than at the opposite end, as figured by Coulter and Chamberlain (1901) for Pinus, and the chromosomes are very large in proportion to the spindle (*fig. 3*). Not infrequently this spindle of the third division was strongly inclined (*fig. 6*), and in such cases the generative cell may be placed in a distinctly excentric position.

The prothallial cells do not promptly degenerate as in the Abieteae, but the second, and sometimes the first also, behaves in a manner unknown in other conifers and only paralleled in Ginkgo and the Cycads. Both nuclei organize a coarse reticulum and a nucleolus, and increasing in size become as conspicuous as the generative nucleus (*figs. 3* and *4*).[2] They still remain flattened and elongated, but their size is such that with the generative cell they may occupy half the diameter of the pollen grain (*fig. 5*). So far the development of the two prothallial cells has been the same, but at this point their paths as a rule diverge. The cytoplasm of the second loses its individuality and becomes indistinguishable from that of the tube (or wall) cell, and its nucleus slips from its former position and lies free in the general cytoplasm. This history may be further complicated by the amitotic division of the nucleus before its liberation (*fig. 7*). In such cases the two nuclei generally slip out in different directions and place themselves on opposite sides of the generative cell (*figs. 8* and *10*). Cases were found, however, where both nuclei had moved out in the same direction and lay side by side (*fig. 9*). This was probably the result of an excentric position of the generative cell.

That the division just described is amitotic is proved by many connecting stages, and by the persistent absence of spindles.

[2] Coulter and Chamberlain (1901) figure both prothallial nuclei as developing a reticulum in *Pinus Laricio*, but this condition is shortly followed by rapid disintegration.

The nucleus before the completion of its division is often much drawn out and thin in the center, as if compressed between the cells above and below. In fact, as the second prothallial nucleus or nuclei move away, the generative cell sinks down and comes in contact with the first prothallial cell (*figs. 7* and *9*). It would be difficult to state the proportional number of cases in which the second prothallial nucleus divides; hundreds of such were found, and in my preparations they were probably as numerous as those in which the division had not occurred.

The first prothallial cell seldom develops further than the stage shown in *fig. 4*. It now begins to degenerate (*fig. 7*), but so slowly that even at the time of shedding it is still conspicuous (*fig. 8*). But while degeneration is the rule for this cell, not a few cases were found where, like the second, it had lost its individuality and liberated its nucleus in the general cavity (*fig. 10*). The nucleus here shows no sign of degeneration, but is apparently as healthy and active as its neighbors. In *fig. 9* two nuclei appear in the first prothallial cell. They are surrounded by dense protoplasm and it is not yet apparent whether they are to be liberated or are to degenerate. In undoubted cases of degeneration the nucleus is often found fragmented into three or more parts.

The generative cell is distinguishable in all cases by its protoplasmic sheath and the structure of its nucleus, which is always denser than any of the other free nuclei of the grain. By comparing the figures it will be seen that the prothallial nuclei after their liberation become much less dense and approach in structure the tube nucleus. They remain more dense, however, than the latter, and are further to be distinguished from it by their size and position.

The question now naturally arises, how much of this history as described is normal and how much is abnormal? The fact that the tree from which this pollen was taken was cultivated under unnatural conditions might lead us to expect abnormalities, and I am inclined to consider as such the fragmentation or liberation of the first prothallial nucleus. But the invariable persistence of

the second prothallial nucleus, whether fragmented or not, convinces me that this at least is normal, and that we have in Podocarpus a case analogous in this respect to Ginkgo and the Cycads. This view is further supported by the presence in the pollen tube, in the only three cases in which I was able to follow it throughout, of three small nuclei in addition to the body cell or its products. *Figs. 14* and *16*, sections from the same pollen tube, show a case of this kind. The absence of early stages in the sprouting of the pollen tube makes a distinction between prothallial and stalk nucleus difficult, but their positions favor the designations given in the figures. There can be little doubt as to the identity of the pollen-tube nucleus (*t n*, *fig. 16*).

Jurányi (1870) twice found two nuclei in the tip of the young pollen tube of *Ceratozamia longifolia*, but the doubling may have here resulted from the abnormal conditions, as the tubes were sprouted on ripe pears. Arnoldi (1900, *a*) figures an extra nucleus in the pollen tube of *Cephalotaxus Fortunei*, and very recently Miss Ferguson (1901, *a*) found two cases in which the pollen grain of *Pinus Laricio* still contained three nuclei after the tube nucleus had passed out. In the case of Pinus the most probable explanation seems to be that the extra nucleus is that of the second prothallial cell, as in Podocarpus.

Perhaps the persistence of one of the prothallial nuclei was once common in all conifers; an ancient character which, though now generally suppressed, may occasionally appear. It is of course possible that the particular plant of Podocarpus from which my results were obtained has a peculiar tendency to such a reversion, and that the peculiarities of its pollen are not characteristic for the species. Whether such is the case only future work can determine.

THE POLLEN TUBE.

On June 26, the date of the first collection, fertilization had already taken place in the majority of cases, and only a few undischarged pollen tubes were found. *Fig. 12* illustrates the body cell before its division, what is probably the stalk nucleus

lying in contact with it below. Another small nucleus was present in addition to the tube nucleus. In this case the pollen tube had reached the prothallium before the archegonia initials could be distinguished from their neighbors. I have found this to be also the case in both Taxodium and Taxus, when the pollen tubes reach the embryo-sac before the beginning of cell formation. In the Abieteae the tubes reach the archegonia only a few days before fertilization. On reaching the prothallium the pollen tube spreads out to an unusual extent. When only one is present it may cover almost the whole tip of the prothallium and send down short spurs on the sides.

Only two cases were found showing the male cells, but these leave no doubt that there is only one functional male cell formed, as in Taxus. *Figs. 13–16* are sections through the same pollen tube, *13–15* being serial. The male nucleus nearest the tip has appropriated all of the protoplasm, leaving the other thrust almost entirely out of the cell, and naked on its outer surface. The difference in the structure of the two nuclei is also marked. The functional one has the usual structure of the male nucleus in gymnosperms—a very dense, close-meshed linin reticulum, difficult to stain, which, except in very thin sections, almost hides the nucleolus. The latter is not shown in the figures, but appears in another section. In both Podocarpus and Taxodium I can confirm Miss Ferguson's (1901, *a*) statement that there is no metaplasmic substance in the male nuclei. An irregular nucleolus is always present. It is the only part of the nucleus that takes the saffranin stain, and this, together with its evidently compound nature and in Taxodium its behavior in fertilization, convinces me that it is composed of chromatin.

The extruded nucleus shown in *figs. 13* and *14* has apparently gone through the same developmental changes as the functional one, but the reticulum has now begun to coagulate, if the word may be used, into more or less separate clumps, and the evidences of degeneration are unmistakable.

The protoplasm of the male cell consists of a denser inner portion immediately surrounding the nucleus, and an outer sheath

which is not at all points sharply distinct from the protoplasm of the pollen tube (*fig. 16*). There is no starch. Goroschankin (1880)[3] found starch in the male cells of the Cupresseae, and Arnoldi (1900) found it in *Sequoia sempervirens*, Cryptomeria, and Taxodium. This I can confirm for Taxodium.

As already stated, the pollen tube was found to contain three nuclei in addition to the male cells.

THE FEMALE PROTHALLIUM.

The macrospore arises deep in the nucellus and is not surrounded by "spongy" tissue such as is found in the Abieteae, Cupresseae, and Taxodieae, and which has so often been erroneously described as of sporogenous character. Miss Ferguson's (1901, *b*) suggestion that the spongy tissue is active in nourishing the prothallium is probably correct; an interpretation I had arrived at from a study of Taxodium.

The youngest stage found is illustrated in *fig. 18*. The prothallium is in the four-celled stage, and at its tip two disorganizing cells are found, which are probably the undeveloped macrospores, but at this late stage it is not safe to draw any conclusion as to their origin. The prothallium is surrounded by cells of the ordinary vegetative type, the innermost of which are disorganizing. The disorganizing cells abut directly on the prothallium, which is not the case where a "spongy" tissue is present.

Stages showing cell formation were not found, but the straight rows of cells conspicuous in young prothallia show that the tissue arises in the usual way by ingrowing tubes. The central region first becomes firm, and in alcohol-fixed material this part remains extended, while the upper and lower buds may be much shrunken. At the time of fertilization the prothallium has reached about two-thirds or three-fourths its full size. *Fig. 21* shows the structure of the prothallium from axis to surface. In the center is a cylinder of very small cells extending from just below the archegonia to near the base. From this row outward the cells increase rapidly in size and become largest near the

[3] I have not seen this paper, but take the statement from Arnoldi (1900).

surface. The outer layer, however, is of an entirely different character. It is composed of very small, regular, epidermis-like cells with dense protoplasm, but almost free from the starch grains found abundantly in other parts. This layer is absent at the tip of the prothallium and is not quite so regular at the base. No such definite layer seems to have been described for other gymnosperms,[4] but in Taxus I have found the outer cells to approach these in character, though not so definitely arranged or so small proportionately. There is little doubt that these surface cells are specially modified for secretion, and it is worth noticing that when a spongy tissue is present there they are not found.

The larger cells of the prothallium, as is usual in conifers, contain many nuclei at the time the embryos are formed (*fig. 20*), while those on the surface have generally only one, or sometimes two.

In only one case were two prothallia found in one ovule (*fig. 19*). Neither had formed archegonia, although the seed had reached its full size. In one of them three or four tracheids were present (*fig. 20*). This will recall the formation of tracheids in the prothallia of ferns in cases of apogamy. In no other case of which I am aware have tracheids been described in the prothallium or endosperms of higher plants.

Hofmeister (1851) found two prothallia in the ovule of *Taxus baccata* and *Pinus silvestris*. He says (p. 127): "Es giebt Bäume von *Pinus silvestris* (ein solcher steht an einer sumpfigen Stelle des Leipziger botanischen Garten), welche, ähnlich der Eybe, in der Mehrzahl ihrer Eychen zwei Embryosäcke entwickeln."[5] Shaw (1896) and Arnoldi (1899) have found it the rule for a number of embryo sacs to be developed in *Sequoia sempervirens*, Arnoldi (1900, *b*) figures five in Cunninghamia, and I have once found two in Taxodium. The case of Gnetum is well known.

[4] Ikeno (1898) figures smaller and denser surface cells in Cycas, but they do not differ so sharply from the adjoining cells below as in Podocarpus.

[5] Farmer (Annals of Botany **6**: 213. 1892) in describing two prothallia in *Pinus silvestris* overlooks this previous discovery by Hofmeister.

THE ARCHEGONIA.

The number of archegonia varies from six or seven to about nine or ten. They are separated from each other by one or more layers of cells, and all open on the upper surface of the prothallium (*fig. 27*). In the youngest stage found, the neck cell was already cut off and had undergone a tangential division (*fig. 22*). In the mature archegonia the neck varies greatly, both in shape and the number of cells (*figs. 23–26*). In one case more than twenty-five cells were counted (*fig. 26*), or there may be only two (*fig. 23*). Perhaps the most common condition is three tiers of four cells each. Murrill (1900) has described considerable variation in the archegonium neck of Tsuga; and in Taxodium also there is much variation.

The jacket cells are not so dense as in many other conifers, and their nuclei do not go to pieces at the maturity of the archegonium, but still retain their shape and structure at the time of fertilization and after (*fig. 31*). Protoplasmic connections between the jacket cells and archegonia were not found, but they were not looked for by special methods, and may be present.

In the position and behavior of the ventral canal nucleus, Podocarpus agrees closely with Taxodium. No membrane is formed separating a ventral canal cell from the egg cell.[6] The nucleus is always closely pressed against the wall of the archegonium at first (*fig. 31*), and in this position it generally remains until the fertilization of the egg. Its position varies greatly. In *fig. 31* it is below the egg nucleus, but it may be placed opposite or above it, but always on the lateral wall and never directly under the neck cells. This retired position has probably been acquired to protect the ventral canal nucleus from harm during fertilization, for, as we shall see, it is to develop further. Both Strasburger (1879) and Belajeff (1893) figure the ventral canal nucleus of Juniperus in a lateral position.[7]

[6] Arnoldi (1900, *a*) emphasizes the absence of such a membrane in *Cephalotaxus Fortunei*.

[7] Arnoldi (1900, *b*) denies the presence of a ventral canal nucleus in Taxodium, Cryptomeria, Cunninghamia, and Sequoia, and even tries to throw doubt on its occur-

In archegonia which have reached maturity and failed to be fertilized the ventral canal nucleus frequently leaves its position at the surface and moves inward (*fig. 28*). It may even come in contact with the egg nucleus (*fig. 29*). Such cases might be interpreted as evidence in favor of the possible fertilization of the egg by the ventral canal nucleus, as suggested by Coulter and Chamberlain (1901, p. 98). In fact, however, the evidence is in the other direction, for though there is never any obstacle to the free approach of the ventral canal nucleus, and though it is often found very near the egg nucleus, or even in actual contact with it, in no case was an embryo found in an archegonium not provided with a pollen tube. In one case both the egg and ventral canal nuclei had divided amitotically into a large number of fragments, not half of which are shown in the figure (*fig. 30*).

In fertilized archegonia the ventral canal nucleus soon leaves its lateral position, increases in size, and frequently divides amitotically (*figs. 32, 34, 35, 50*). Its reticulum becomes denser and may approach that of the egg nucleus in character (*fig. 35*), as described by Chamberlain (1899) in *Pinus Laricio*. The division of the nucleus, its large size and healthy appearance, and its long persistence (*fig. 50*) leave little doubt that its function is to assist in nourishing the embryo. The persistence of the second male nucleus for a considerable time in the upper part of the archegonium has been described in a number of cases, and I am aware that my figures do not prove conclusively that the nuclei just described do not come from the pollen tube. Degenerating nuclei have been found near the pollen tube (*fig. 33*) which probably come from it, but in all such cases another nucleus was also present. This fact, together with the size, structure, and position of what has been called the ventral canal nucleus, convinces me of the correctness of my interpretation.

rence in the Cupresseae, although both Strasburger and Belajeff have given the spindles of the division in Juniperus. He is certainly mistaken so far as Taxodium is concerned, and I shall be greatly surprised if a ventral canal nucleus is not eventually found in all conifers.

The mature archegonium is shown in *fig. 31*. There are still vacuoles present towards the base, and a mass of kinoplasm completely surrounds the egg nucleus. In the center is another smaller dense area, and at the base a third appears. When the vacuole is nearer the center of the archegonium, only two kinoplasmic masses are present, one above and one below. The upper one does not always completely surround the nucleus, but is often only in contact with it at the side. As I have described these masses in some detail in Taxodium, and as they seem almost identical in the two genera, they need not detain us here.

At the tip of the egg cell just under the neck a collection of plastic material is figured. It stains red in saffranin and may easily be mistaken for a disorganizing ventral canal cell. It is generally present in both Podocarpus and Taxodium.

The pollen tube enters the neck, penetrates for some distance into the archegonium, and discharges its contents into the egg (*fig. 17*). The opening in the pollen tube is distinctly seen in *fig. 32*, where some of the protoplasm of the egg seems to have surged up through it after the discharge. The archegonium wall does not show the thickening around and below the neck characteristic of the Cupresseae (among which Taxodium must be placed), but is thin throughout and permits of much extension by the pollen tube (*figs. 32, 33*).

Strasburger (1892) has described the reduction of one male cell in Taxus and the Abieteae when the pollen tube fertilizes only one archegonium, and the recent work of Murrill (1900) and Miss Ferguson (1901, *a*) confirms this.[8] Where the archegonia are collected into complexes, the pollen tubes do not enter their necks, and both male cells are functional.

THE EMBRYO.

Fertilization stages were not found, but from *fig. 32* it seems probable that the fusion nucleus moves to the base of the archegonium before dividing, as in Juniperus (Strasburger, 1879), Taxus (Jäger, 1899), Taxodium,[9] Cryptomeria, and Sequoia

[8] Cephalotaxus (Arnoldi, 1900, *a*) is a possible exception.

[9] Noted for Taxodium in my preliminary paper, *l. c.*

(Arnoldi, 1900, *b*). The two nuclei here lie side by side, and are not surrounded by starch or furnished with so distinct a protoplasmic sheath as in the Cupresseae and Taxodieae. A denser and more granular area can be observed in immediate contact with the nuclei, but it is not sharply defined and fades imperceptibly in the general protoplasm of the archegonium. In *fig. 33* the second division has just occurred, and the nuclei, only two of which are shown, have not yet reached their full size. When the sixteen-celled stage is reached, the protoplasm of the embryo has become separated from the disorganizing area above (*fig. 34*). There is probably no further division before cell walls are formed, but the absence of important stages here leaves this point in doubt.

Fig. 38 shows the proembryo just as it is breaking through the base of the archegonium. It consists here, as invariably, of three tiers. First is a rosette of generally fourteen nuclei, which are separated from one another by cell walls, but are in open communication with the archegonium above; next come the suspensors, also usually fourteen in number, and below there is the large tip cell, with two nuclei not yet separated by a wall.

It will be noticed that the walls between the rosette nuclei seem to continue those separating the suspensors below. This is strong evidence that the rosette and the suspensors are established only after cell walls are formed, through the division of an originally single upper tier. It is in this way that they are formed in Taxodium. Between rosette and suspensors a thick cellulose plug is soon formed, a novelty, I believe, in the gymnosperm embryo (*figs. 38, 39, 41*). As the suspensors elongate, their nuclei, contrary to the rule, remain for some time at the archegonial end (*fig. 39*). This is probably connected with the deposition of the cellulose plug. The first division of the tip cell is longitudinal (*fig. 40*); and this is probably followed by another longitudinal wall in each cell, giving four tip cells in a tier. Such a stage was not found, but the frequent splitting of the proembryo into four parts suggests it. In *fig. 44* three embryos of such a group are shown, each at the tip of a single

suspensor. In *fig. 43* the three lower embryos have come, with one other, from a single archegonium, while the upper larger one is from another archegonium, in this case the suspensors not having separated. Fourteen suspensors appear in cross section in *fig. 36* and thirteen in *fig. 41*. As the proembryo penetrates further and further into the prothallium a number of the suspensors drop out at different levels, and cross sections just above the tip cells show a greatly reduced number (*fig. 37*). Jäger (1899) has described a similar behavior in Taxus. If the tip cells separate, each is usually furnished with a single suspensor (*figs. 43, 44*). Protoplasmic connections occur between the suspensor cells near the archegonium (*fig. 42*). Although the individual fibers were scarcely distinguishable, the appearance leaves no doubt of their presence.

The embryonal tubes may appear very early (*fig. 46*), but usually not before the stage shown in *fig. 48*. They are formed by the almost simultaneous elongation of all the cells on the proximal surface of the embryo, and by their growth force it deeper into the prothallium.

Various stages in the development of the embryo are given in *figs. 43–48*. If the suspensors do not separate, each of the four-tip cells generally divides first by a transverse wall; if they do separate, the first division of the single tip cell is generally longitudinal. Further than this no regularity is apparent.

A median longitudinal section of the oldest embryo found is given in *fig. 49*. There is no indication as yet as to where the root tip is to appear, and a distinction between dermatogen, periblem, and plerome has not arisen.

In one case an embryo was found which had grown directly upward and passed out between the prothallium and nucellus (*fig. 50*), where, bending sharply, it continued its course for some distance.

AFFINITIES OF PODOCARPUS.

In looking over the results of this paper, we find that Podocarpus agrees with the Abieteae in the gross structure of the

pollen grain (long known, of course), in the presence of two male prothallial cells, in the distribution and arrangement of the archegonia, in the reduction of the number of functional male nuclei to one (?), and in the penetration of the pollen-tube into the archegonium. The first three of these characters, at least, are of much taxonomic importance, as is shown by their constancy in the different groups. On the other hand, the structure and manner of formation of the proembryo, where points of difference appear, although constant, so far as known in the Abieteae,[10] are by no means so constant in other families, and are not of such value in classification.

When it is noted further that none of the characters of agreement mentioned are found in the Cupresseae, and few of them in any other conifers, it seems safe to conclude that in the Podocarpeae are to be found the nearest living relatives of the Abieteae.

SUMMARY.

1. The pollen grain contains two prothallial cells.

2. The second prothallial nucleus persists and is found later in the tip of the pollen tube. It may divide amitotically.

3. The mature pollen grain sometimes contains as many as six nuclei, probably abnormally.

4. The pollen tube reaches the prothallium before the archegonial initials can be distinguished. It contains no starch.

5. There is but one functional male cell formed.

6. There is no "spongy" tissue around the macrospore.

7. The prothallium is furnished with a distinct epidermis-like layer of small regular cells which are modified for secretion.

8. Two large prothallia were once found in the same ovule. One of them contained tracheids.

9. The archegonia vary from about seven to eleven, and all open on the micropylar end of the prothallium. The neck varies greatly in shape and number of cells. Two large kinoplasmic

[10] Only the interarchegonial development is referred to here. Many variations are recorded in its later history.

masses are generally present in the mature archegonium, one in contact with or surrounding the egg nucleus, the other near the base.

10. The ventral canal nucleus is not separated from the protoplasm of the egg by a membrane. It persists for some time after fertilization and probably assists in nourishing the embryo.

11. The pollen tube enters the archegonium to discharge its contents.

12. Four divisions of the fusion nucleus occur before cell walls are formed.

13. The proembryo consists of three tiers of cells, the upper two of fourteen each, the lower of one cell containing two nuclei.

14. A heavy cellulose plug is formed between the suspensors and the rosette.

15. The suspensors may separate and several embryos develop from one archegonium.

16. The Podocarpeae are considered as the nearest living relatives of the Abieteae.

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EXPLANATION OF PLATES V–VII.

The figures, with the exception of *fig. 19*, were drawn with Leitz camera lucida, and reduced one-half by photography. The magnification given in each case is one-half that of the original drawing. Figures from *Podocarpus coriacea* are so designated. All others are from material collected in Darlington, S. C., from a species probably the same, but not certainly identified. The abbreviations used are: *bc*, body cell; *dn*, degenerating male nucleus; *en*, egg nucleus; *et*, embryonal tubes; *g*, generative cell; *mc*, male cell; p^1, 1st prothallial cell, or the two nuclei arising from the division of its nucleus; p^2, 2d prothallial cell, or the two nuclei arising from the division of its nucleus; *r*, rosette cells; *s*, suspensors; *stn*, stalk nucleus; *tn*, tube nucleus; *vn*, ventral canal nucleus, or group of nuclei arising from its division.

PLATE V.

FIG. 1. First division of pollen grain. × 1550.

FIG. 2. Second division of pollen grain. × 1550.

FIG. 3. Third division of pollen grain. × 1550.

FIG. 4. The same, later stage. × 1550.

FIG. 5. Pollen grain soon after third division; starch still present. ×750.

FIG. 6. Oblique spindle of third division. × 750.

FIG. 7. Pollen grain soon after the amitotic division of the second prothallial nucleus. × 1550.

FIG. 8. Five nuclei in pollen grain, two of which have arisen from the amitotic division of the second prothallial nucleus. × 750.

FIG. 9. Pollen grain with six nuclei; the first prothallial nucleus has also divided amitotically. × 750.

FIG. 10. Pollen grain with five nuclei, all of which are lying free in the general cytoplasm: the generative nucleus is furnished here, as always, with a special protoplasmic sheath. × 750.

FIG. 11. Section of wall of microsporangium just before the first division of the pollen grain. × 315.

FIG. 12. Body cell and stalk nucleus, after the pollen tube has reached the prothallium. × 315.

FIGS. 13–16. Sections through the same pollen tube, showing functional male cell, degenerating male nucleus, and three small nuclei; *figs. 13, 14,* and *15* are consecutive. × 315.

FIG. 17. Diagram showing pollen tube from which the above figures mere made; other pollen tubes and a fertilized archegonium are also shown. × 30.

FIG. 18. Four-celled female prothallium with two disorganizing microspores at tip. × 150. *P. coriacea.*

FIG. 19. Diagram of two mature prothallia in the same nucleus; the cross indicates the position of the tracheids. × 4½. *P. coriacea.*

FIG. 20. Tracheids found in one of the prothallia represented in the above diagram; they are surrounded by multinucleate cells of the usual type. × 150. *P. coriacea.*

PLATE VI.

FIG. 21. Median longitudinal section of prothallium from center to surface, showing small cells of the axial rows, and a single layer of small epidermis-like surface cells. × 30.

FIG. 22. Young archegonium; neck cell shows a cross division. × 150. *P. coriacea.*

FIGS. 23–26. Neck cells of mature archegonia, showing great variation. × 150.

FIG. 27. Diagram of tip of ovule; archegonia mature. × 30.

FIG. 28. Egg nucleus and ventral canal nucleus in mature archegonium. × 150.

FIG. 29. Egg nucleus and ventral canal nucleus in contact. × 315.

FIG. 30. Numerous nuclei which have arisen from amitotic division of the egg and ventral canal nuclei in the tip of the archegonium. × 315.

FIG. 31. Mature archegonium; ventral canal nucleus pressed against the wall below the egg nucleus; three kinoplasmic masses present, one surrounding the egg nucleus; at the tip is a collection of plastic material. × 150.

FIG. 32. Two-celled embryo in base of archegonium; ventral canal nucleus above. × 150.

FIG. 33. Four-celled embryo; pollen tube still visible above, with a nucleus near its tip. × 150.

FIG. 34. Sixteen-celled embryo; several nuclei in the disorganizing cytoplasm above. × 150.

FIG. 35. Two nuclei in tip of an archegonium in the base of which is an embryo in the stage shown in *fig. 38*. × 315.

FIG. 36. Cross section of a group of fourteen suspensors. × 315.

FIG. 37. Cross section of a group of five suspensors just above the tip cells. × 315.

PLATE VII.

FIG. 38. Young embryo breaking out of archegonium. × 315.

FIG. 39. Slightly older embryo; two nuclei in one tip cell. × 315.

FIG. 40. Still older embryo, with two tip cells, one of which contains two nuclei. × 315.

FIG. 41. A group of thirteen suspensors; at their archegonial end is the thick cellulose plug. × 315.

FIG. 42. Protoplasmic connections between adjoining suspensors of a group. × 1550.

FIG. 43. A group of embryos from two archegonia. × 150.

FIG. 44. Another group of embryos from a single archegonium. × 150.

FIG. 45. Young embryo before development of embryonal tubes. × 150.

FIG. 46. Embryonal tubes, developed unusually early. × 150.

FIG. 47. Embryo just before formation of embryonal tubes. × 150.

FIG. 48. Origin of embryonal tubes. × 150.

FIG. 49. Older embryo. × 150.

FIG. 50. Abnormal embryo, growing upwards and passing between prothallium and nucellus. × 150.

NEW OR LITTLE KNOWN NORTH AMERICAN TREES. IV.

CHARLES S. SARGENT.

Prunus (PRUNOPHORA) **tarda,** n. sp.—Leaves convolute in vernation, oblong to obovate, acute, or acuminate and short-pointed at the apex, gradually narrowed and rounded or cuneate at the base, finely serrate, with straight or incurved teeth tipped with minute dark glands, cinereo-tomentose as they unfold, at maturity thick and firm in texture, dull yellow-green and glabrous on the upper surface, pale and pubescent or puberulous on the lower surface along the prominent yellow midribs and primary veins, 1½–3 in. long, ¾–1¼ in. wide; petioles stout, tomentose, ⅓ to ½ in. long, biglandular at the apex, with prominent dark stalked, often deciduous, glands, or eglandular; stipules acicular, ⅓ in. long, caducous. Flowers in 2 or 3-flowered subsessile umbels; pedicels slender, glabrous, ⅝ to ¾ in. long; calyx-tube narrowly obconic, glabrous toward the base, villose above, the lobes acute, entire, villose on the outer surface, coated within with thick, hoary tomentum; petals oblong-obovate, gradually narrowed below, short-clawed; filaments and pistil glabrous. Fruit short-oblong to subglobose, yellow, purple, red, dark blue, or black, ⅓ to ½ in. in diameter, acidulous; stone slightly compressed, obscurely ridged on the ventral suture, only slightly grooved on the dorsal suture, rugose, acute and apiculate at the apex, rounded at the base, ⅓ to ½ in. long.

A tree 20 to 25 feet in height with a trunk 18 or 20 in. in diameter, stout wide-spreading branches, slender, lustrous, light red-brown branchlets marked by occasional dark lenticels, and minute, acuminate, chestnut-brown buds. The bark of the trunk is light brown tinged with red, ½ to ⅝ in. thick, divided by shallow, interrupted fissures into flat ridges broken on the surface into small, loose, plate-like scales, and hardly distinguishable from that of *Castanea pumila* growing with it.

Flowers early in April. Fruit ripens late in October and November.

Glades and open woods near Marshall, Texas, in dry, gravelly soil, to western Louisiana and southern Arkansas. First noticed at Marshall on April 19, 1901, by *William M. Canby*, *B. F. Bush*, and *C. S. Sargent.*

Well distinguished from *Prunus umbellata*, with which perhaps it may have been confounded, by its remarkable bark, which differs from that of all American plum trees, and by its variously colored, very late-ripening fruit.

Crataegus Bushii, n. sp.—Leaves obovate, broad and rounded or acute at the apex, to elliptical, gradually narrowed, cuneate, and entire below the middle, coarsely serrate above, with straight gland-tipped teeth; when they unfold, green above, pale below, villose, with short white hairs on both sides of the midribs and veins; nearly fully grown when the flowers open, and then dark green and lustrous on the upper surface, slightly villose on the upper side of the midribs; at maturity coriaceous, very lustrous, 1¼ to 1½ in. long, ½ to 1 in. wide, with stout midribs deeply impressed above, and few slender prominent primary veins; on vigorous leading shoots usually elliptical, acute, coarsely serrate, frequently 3 in. long and 1½ in. wide; petioles stout, grooved, margined above, at first villose, finally glabrous, usually about ½ in. long; stipules linear-lanceolate or oblanceolate, glandular-serrate or entire, ¼ in. long, caducous. Flowers from ¾ to 1 in. in diameter in broad, compound, many-flowered, glabrous corymbs; bracts and bractlets linear, entire, caducous; calyx-tube broadly obconic, glabrous, the lobes elongated, linear-lanceolate, entire or occasionally slightly dentate, reflexed after anthesis; stamens 20; anthers large, bright rose-color; styles 2 or 3, surrounded at the base by conspicuous tufts of pale hairs. Fruit on slender peduncles in few-fruited drooping clusters, oblong, green tinged with dull red, ⅓ in. long; calyx-cavity broad and shallow, the lobes only slightly enlarged, erect and incurved, mostly deciduous before the ripening of the fruit; flesh thin, green, dry, and hard; nutlets 2 or 3, broad, prominently ridged on the back, ¼ in. long.

A tree 15 to 20 feet in height with a trunk 8 or 10 in. in diameter, covered with dark red-brown, fissured bark broken into small, closely appressed scales, small, spreading branches forming a broad, irregular, open

head, slender nearly straight glabrous branchlets, orange-green when they first appear, bright red-brown, lustrous, and marked by occasional oblong pale lenticels during their first summer, and dull gray-brown in their second year, and unarmed or sparingly armed with stout straight spines 1 ½ to 1¾ in. long.

Flowers about the 20th of April. Fruit ripens late in October or in November.

Fulton, Arkansas, in rich upland woods, *B. F. Bush*, April 4, 1900, April and October 1901.

The large and abundant flowers of *Crataegus Bushii*, with their pure white petals and large rose-colored anthers, and its dark lustrous leaves, make this species one of the most beautiful of the thorns of the Crus-galli section. From *Crataegus Crus-galli* of Linnaeus it differs in the number of stamens, in the smaller green fruit, in the presence of hairs on the young leaves, and in the absence or infrequency of spines.

Crataegus edita, n. sp.—Leaves oblong-obovate to oval, acute or acuminate at the gradually narrowed apex, gradually narrowed and cuneate at the entire base, coarsely and often doubly serrate above, with glandular teeth; when the flowers open dark green, lustrous and scabrate above with short rigid pale hairs, and pubescent or puberulous below particularly on the slender midribs and remote slightly raised primary veins; at maturity coriaceous, dark green, lustrous and slightly roughened on the upper surface, pale yellow-green and scabrate on the lower surface, 1½ to 2 in. long, ½ to 1 in. wide, or on vigorous shoots often slightly lobed, more coarsely serrate, 3 in. long, 1½ in. wide; petioles stout, winged above, villose, ultimately pubescent; stipules linear, glandular-serrate, villose, caducous. Flowers ½ to ⅔ in. in diameter in slightly villose few-flowered slender-branched compound narrow corymbs; bracts and bractlets linear, glandular, caducous; calyx-tube narrowly obconic, glabrous or slightly villose below, the lobes linear-lanceolate, entire, obscurely glandular-serrate, glabrous on the outer surface, puberulous on the inner surface, reflexed after anthesis; stamens 20; anthers small, rose-colored; styles 2 or 3. Fruit on stout glabrous or slightly villose peduncles, in few-fruited drooping clusters, short-oblong, full and rounded at the ends, slightly pruinose, dull green tinged with red, ¼ to ⅓ in. long;

calyx-tube prominent, with a broad deep cavity and elongated spreading lobes puberulous on the inner surface; flesh thin, green, dry and hard; nutlets 2 or 3, broad, prominently ridged with broad low ridges, light brown, ¼ in. long.

A tree in low moist ground sometimes 40 feet in height with a trunk a foot in diameter free of branches for 18 or 20 feet and covered with dark fissured scaly bark, stout wide-spreading branches forming a broad symmetrical flat-topped head, and slender nearly straight branchlets marked by numerous dark oblong lenticels, orange-brown and villose when they first appear, dull red-brown and often slightly villose during their second season, becoming light dull gray-brown the following year, and armed with stout straight chestnut-brown ultimately dull gray spines 1 to 2 in. long.

Marshall, Texas, common in low wet woods and on dry hills, *W. M. Canby, B. F. Bush,* and *C. S. Sargent,* April 19, 1901; Shreveport, Louisiana, *W. M. Canby, B. F. Bush,* and *C. S. Sargent,* April 21, 1901; Opalusas, Louisiana, *C. S. Sargent,* March, 1900, in bud only.

Crataegus edita belongs to the small group of Crus-galli-like species represented by *Crataegus berberifolia,* from which it differs in its less tomentose lustrous thicker scabrate leaves which are gradually narrowed and acute and not rounded at the broad apex, by its slightly villose not tomentose cymes and calyx, and by its smaller later-ripening dry green fruit. That of *Crataegus berberifolia* is nearly globose and bright orange color with a bright red cheek.

Crataegus fecunda, n. sp.—Leaves oblong-obovate to oval or broadly ovate, acute or rarely rounded and short-pointed at the apex, gradually or abruptly narrowed below, coarsely and usually doubly serrate, with broad spreading glandular teeth except toward the entire obscurely ciliate base; when the flowers open dark green, lustrous and scabrate on the upper surface with short pale appressed caducous hairs, and pale yellow-green and villose on the lower surface along the midribs and primary veins, with occasional white hairs; at maturity thin but firm, glabrous, dark green and very lustrous above, pale yellow-green below, 2 to 2½ in. long, 1½ to 2 in. wide, with stout midribs and remote primary veins only slightly impressed on the upper surface and after midsummer frequently bright red below; on leading shoots often slightly lobed, usually more or less convex by the drooping sides, 3 to 4 in. long, 2 to 3 in. wide; petioles stout, more or less winged above, grooved on the upper side, villose, often

glandular with scattered dark glands, glabrous and red at maturity, ½ to ¾ in. long; stipules linear to semi-lunate, and stipitate, coarsely glandular-serrate, ½ to ¾ in. long. Flowers ¾ in. in diameter in broad open many-flowered compound slightly villose corymbs; bracts and bractlets linear to oblong-obovate, coarsely glandular-serrate; calyx-tube narrowly obconic, more or less villose, the lobes elongated, acuminate, irregularly glandular-serrate, with stipitate dark red glands, villose on the inner surface, spreading after anthesis; stamens usually 10, occasionally 12 to 15; anthers small, dark purple; styles 2 or 3. Fruit on slender peduncles often ½ in. long, in broad drooping many-fruited glabrous clusters, short-oblong to subglobose, full and rounded at the ends, until nearly fully grown covered with long soft pale scattered hairs, at maturity dull orange-red, marked by numerous small dark lenticels, ⅞ to 1 in. long; calyx-cavity deep, comparatively narrow, the lobes linear-lanceolate, erect and incurved, coarsely glandular-serrate above the middle, dark red at the base on the upper surface; flesh remarkably thick, firm and hard, pale green, dry and sweet; nutlets 2 or 3, comparatively small, light-colored, rounded and obscurely ridged on the back, ⅓ in. long.

A tree 20 to 25 feet in height with a trunk 10 or 12 in. in diameter, covered with dark red-brown bark broken into small closely appressed scales, wide-spreading branches forming a broad symmetrical round-topped rather open head, and stout slightly zigzag branchlets marked by large pale oblong lenticels, dark green and lustrous and covered with soft matted pale hairs when they first appear, glabrous, lustrous and light orange-green during their first summer, and ashy gray in their second season, and armed with numerous very slender straight or slightly curved chestnut-brown shining spines 2 to 2½ in. in length.

Flowers near St. Louis toward the end of May and in the Arnold Arboretum during the first week in June. Fruit ripens and begins to fall toward the end of October, when the leaves assume brilliant shades of orange and scarlet or are often of a deep rich bronze color.

Rich woodlands, Allenton, Missouri, October, 1882, and Illinois bottoms opposite St. Louis, May, 1883, *George W. Letterman*.

Cultivated for many years in the Arnold Arboretum where it was raised from seeds collected by Mr. Letterman and where it now flowers and ripens its fruit.

Crataegus fecunda appears to be related to the *Crataegus elliptica* of Aiton but not of later authors, and to a group of species or varieties cultivated in Europe as *Crataegus Crus-galli splendens*, *Crataegus ovalifolia*, and *Crataegus prunifolia*, forms, although evidently of American origin, which are not now known to grow naturally in the United States. From these *Crataegus fecunda* differs in its thinner, larger, usually more acute and more coarsely dentate leaves, in its slightly villose not tomentose cymes, in the form, color and texture of the fruit, in the color of the young branches and in its more slender and more scattered spines.

Crataegus Georgiana, n. sp.—Leaves ovate, acute, or acuminate at the apex, full and rounded or broadly cuneate at the base, finely and often doubly serrate, with straight or incurved gland-tipped teeth, and slightly lobed with numerous short acute lateral lobes; as they unfold bronze-yellow and glabrous with the exception of a few caducous hairs on the upper surface; nearly half grown when the flowers open and then thin, dark yellow-green above and pale below; at maturity thin but firm in texture, dark blue-green on the upper surface, pale on the lower surface, 1½ to 2 in. long, 1 to 1¼ in. wide, with slender yellow midribs and three or four pairs of primary veins only slightly impressed above; on vigorous leading shoots often 3 in. long and 2 in. wide, sometimes deltoid and usually more deeply lobed than the leaves of lateral branchlets; petioles slender, grooved, often short-winged at the apex by the abruptly decurrent bases of the leaf-blades, usually about ¾ in. long; stipules linear-lanceolate, finely glandular-serrate, more or less deeply-tinged with red, ½ to ¾ in. long, caducous. Flowers ¾ in. in diameter on slender pedicels in usually 5–7-flowered compact thin-branched compound corymbs; bracts and bractlets linear, glandular, turning red in drying; calyx-tube broadly obconic, the lobes gradually narrowed from broad bases, acuminate, entire, obscurely and irregularly serrate; stamens 20; anthers small, bright rose-color; styles 5, surrounded at the base by a thin ring of pale tomentum. Fruit on slender peduncles, in few-fruited drooping clusters, full and rounded at the ends, often obscurely 5-angled, dull russet green, ⅜ to ½ in. long; calyx-lobes only slightly enlarged, mostly deciduous before the fruit falls, leaving a well defined

ring at the summit of the short calyx-tube; flesh very thin, light green, dry and hard; nutlets thin, rounded, irregularly grooved on the back, about ¼ in. long.

A tree 25 to 30 feet in height with a tall trunk 10 or 12 in. in diameter, covered with dark red-brown scaly bark, stout wide-spreading branches, forming a broad symmetrical round-topped head, and slender, straight, or somewhat zigzag branchlets marked by occasional small, pale lenticels, dark green tinged with red when they first appear, becoming dull reddish-brown during their first season, and gray or light reddish-brown during their second year, and armed with straight or slightly curved, slender, bright chestnut-brown, lustrous spines, rarely more than 1½ in. in length.

Flowers about the 20th of April. Fruit ripens and falls early in October.

Low meadows, in rich moist soil near Rome, Georgia; not rare. *W. M. Canby* and *C. S. Sargent*, May 6, 1899; *C. S. Sargent*, April 22 and October 7, 1900.

Crataegus sordida, n. sp.—Leaves rhomboidal, acute, or obovate, and rarely rounded at the apex, gradually narrowed from near the middle and cuneate at the entire base, serrate above, with slender, straight, or incurved glandular teeth, and occasionally irregularly divided above the middle into short, broad, acute lobes; about half-grown when the flowers open, and then membranaceous, lustrous, glabrous with the exception of a few scattered caducous hairs on the upper surface; at maturity subcoriaceous, dark green and lustrous above, pale below, about 1½ in. long and 1¼ in. wide; on leading shoots often oblong-obovate to oval, coarsely dentate and generally divided above the middle into 1 or 2 pairs of short lobes, 3 to 4 in. long, 2 to 2½ in. wide; petioles stout, glandular, more or less winged toward the apex, at first villose but soon glabrous, ½ in. long, often bright red in the autumn; stipules linear, acuminate, glandular, with minute red glands, caducous. Flowers 1 to 1¼ in. in diameter, fragrant, in few-flowered, compact, compound, slightly villose corymbs; bracts and bractlets linear, glandular-serrate, caducous; calyx-tube narrowly obconic, glabrous, the lobes narrow, acuminate, villose on the inner surface, reflexed after anthesis; petals dull, dirty white; stamens 20; anthers small, rose-color; styles 2 or 3, surrounded at the base by a

narrow margin of pale hairs. Fruit on slender peduncles in few-fruited drooping glabrous clusters, dark dull red, ⅓ to ½ in. in diameter; calyx prominent, with a broad shallow cavity and elongated, coarsely serrate, appressed or incurved lobes; flesh thin, yellow, dry and mealy; nutlets 2 or 3, broad, rounded, and ridged on the back with low wide ridges, ¼ in. long.

A slender tree, 20 to 25 feet in height, with a tall stem 5 or 6 in. in diameter, covered with dark furrowed and scaly bark, and often armed with long-branched spines, ascending branches forming a narrow oval head, and slender, nearly straight, branchlets, dark orange-green and villose when they first appear, marked by large, oblong, pale lenticels, becoming glabrous and bright chestnut-brown in their second season, and dull reddish-brown the following year, and armed with numerous slender, nearly straight, bright chestnut-brown lustrous spines 1 to 2½ in. long.

Flowers during the first week in May. Fruit ripens about the middle of September and soon falls.

Low woods and the gravelly banks of small streams, Ripley county, southeastern Missouri, *B. F. Bush*, Monteer, July 26, 1899, Pleasant Grove, August 8, 1899; *C. S. Sargent*, Pleasant Grove, September 30, 1900; *B. F. Bush*, Pleasant Grove, May 7, and Grandin, May 8, 1901.

Probably best associated with *Crataegus collina* of Chapman, *Crataegus sordida* differs from that species in its ascending, not wide-spreading, branches, by the much larger later fragrant flowers, which have narrow glabrous calyx-tubes, dull dirty white petals, rose-colored anthers, and 2 or 3 styles, while in the flowers of *Crataegus collina* the calyx-tube is broadly obconic and tomentose or villose, the petals pure white, the anthers yellow, and the styles 5 in number.

Crataegus sera, n. sp.— Leaves oblong-ovate, acute, rounded, truncate or slightly cordate, particularly on vigorous shoots at the broad base, irregularly divided into four or five pairs of short acute lateral lobes, sharply and sometimes doubly serrate nearly to the petiole, with straight glandular teeth; unfolding with the opening of the flowers and then pubescent above and coated below with thick hoary tomentum; at maturity membranaceous, dark yellow-green and glabrous on the upper surface, tomentose on the lower surface, 3 to 4 in. long, 2½ to 3 in. wide, with slender midribs slightly impressed above and thin remote primary veins extending to the points of the lobes; petioles slender, at first tomentose, ultimately pubescent, 1 to

1½ in. long; stipules linear, acuminate, glandular-serrate, villose, ¼ in. long, caducous; or on vigorous shoots lunate, abruptly acuminate, ½ in. long. Flowers ¾ in. in diameter, in compact compound many-flowered tomentose corymbs; bracts and bractlets lanceolate or oblanceolate, coarsely glandular-serrate, villose or tomentose, conspicuous, caducous; calyx-tube broadly obconic, coated with long matted pale hairs, the lobes broad, acute or acuminate, glandular-serrate, with large dark glands, tomentose on the outer surface, villose on the inner surface; stamens 20; anthers pale yellow; styles 4 or usually 5. Fruit on puberulous peduncles in drooping few-fruited clusters, obovate to oblong, dull dark red, marked by small pale lenticels, usually slightly villose or puberulous at the ends, about ⅔ in. long and ½ in. wide; calyx-cavity broad and shallow, the lobes enlarged, conspicuously glandular-serrate, erect and incurved, often deciduous before the ripening of the fruit; flesh thick, yellow, dry, and mealy; nutlets 4 or usually 5, thin, light brown, irregularly grooved on the back, with broad shallow grooves, ¼ in. long.

A tree 30 to 40 feet in height with a tall straight trunk 12 to 18 inches in diameter covered with pale slightly furrowed bark, thick branches forming a broad round-topped symmetrical head, and slender slightly zigzag branchlets marked by small oblong pale lenticels, coated when they first appear with dense hoary tomentum, light red-brown and puberulous during their first season and ultimately pale orange-brown, mostly unarmed or armed with occasional straight or slightly curved bright chestnut-brown spines 1¼ to 1½ in. long.

Flowers during the first week of May. Fruit ripens early in October. Low moist soil in the neighborhood of streams.

Belle Isle, in the Detroit river, Michigan, *C. S. Sargent*, May 23, 1899, September 25, 1901; woods adjacent to the Calumet river near Calumet, Illinois, *E. J. Hill*, May and September 1896 and 1897, May 1900; *C. S. Sargent*, September 29, 1901.

Probably often confounded with *Crataegus mollis* of Scheele, *Crataegus sera* will perhaps be found to be a common tree in southern Michigan, northern Indiana, and in northern and central Illinois. It may be distinguished from *Crataegus mollis* by its much thinner more oblong and rarely cordate leaves, by its smaller flowers, and smaller much later-ripening usually obovate fruit, the fruit of *Crataegus mollis* mostly falling toward the end of August or early in September.

Crataegus corusca, n. sp.— Leaves ovate, acute, truncate, rounded or slightly cordate at the broad base, irregularly divided into 4 or 5 pairs of short acute lateral lobes, doubly serrate with straight slender glandular teeth; in early spring coated above with short soft pale hairs and glabrous below; at maturity thin but firm in texture, glabrous, dark yellow-green and very bright and shining on the upper surface, pale yellow-green on the lower surface, 2 to 2½ in. long and wide, with slender pale midribs and primary veins only slightly impressed above; on vigorous leading shoots 3½ to 4 in. long and 3 in. wide, often deeply divided into narrow acute lobes; petioles slender, nearly terete, slightly glandular, at first villose, ultimately glabrous and dark red below the middle, 1¼ to 1½ in. long; stipules narrowly obovate, acute, glandular-serrate; on leading shoots lunate, coarsely dentate, ½ to ¾ in. wide. Flowers ¾ in. in diameter, in compact compound many-flowered corymbs coated with matted white hairs; bracts and bractlets linear-lanceolate, glandular-serrate; calyx-tube broadly obconic, glabrous, or villose below, the lobes acute from broad bases, coarsely glandular-serrate, villose on the inner surface; stamens 20; anthers small, pale pink; styles 4 or 5. Fruit in few-fruited drooping glabrous clusters on stout peduncles, ¾ to nearly 1 in. long, oblong to obovate, bright cherry-red, lustrous and marked by scattered dark lenticels, ⅝ to ¾ in. long, ½ to ⅝ in. wide; calyx-cavity deep, comparatively narrow, the lobes gradually narrowed and acute, slightly glandular-serrate, usually deciduous before the ripening of the fruit; flesh thick, yellow, dry and mealy; nutlets 4 or 5, dark-colored, rounded on the back, ¼ in. long.

A tree 18 or 20 feet in height with a tall trunk 8 or 10 in. in diameter, wide-spreading branches forming a handsome symmetrical head, and stout branchlets marked by numerous minute pale lenticels, dark green and villose when they first appear, becoming bright red during their first summer and light orange-brown and very lustrous during their second year, and armed with stout nearly straight bright chestnut-brown spines often 3 in. long.

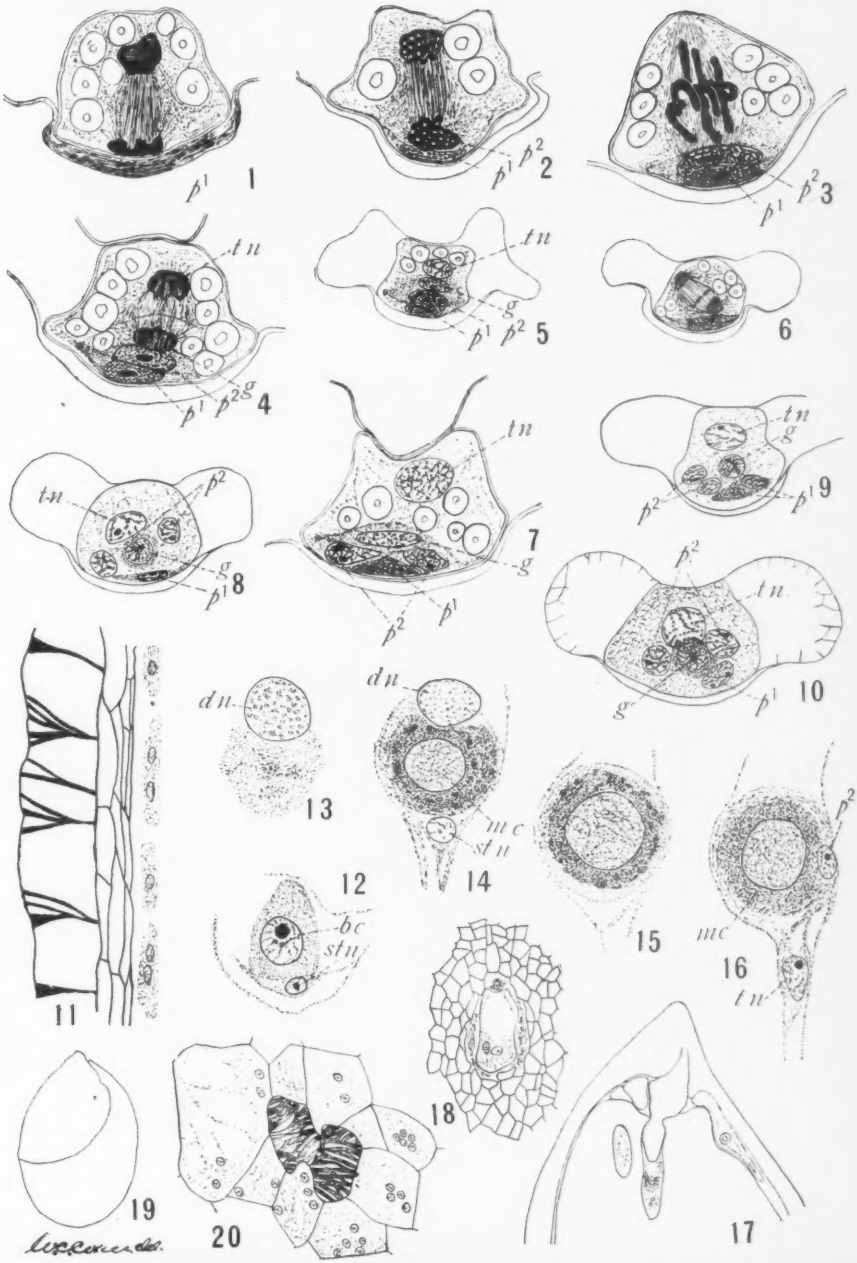
Flowers the middle of May. Fruit ripens and begins to fall about the 20th of September, continuing to fall gradually until the end of October.

Sandy shores of Lake Zurich, Lake county, Illinois, *E. J. Hill*, September, 1899; *E. J. Hill* and *C. S. Sargent*, September, 1900; *E. J. Hill*, May, 1901.

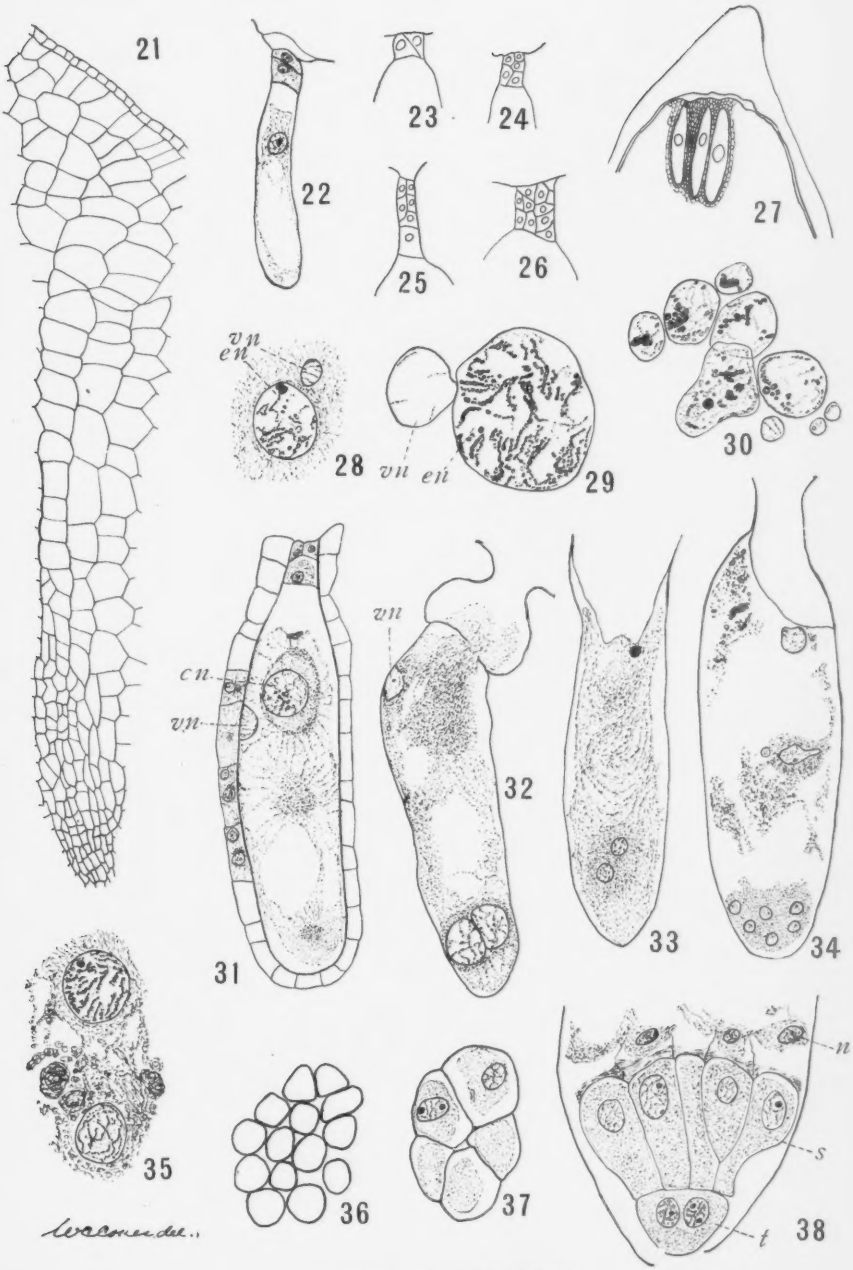
Crataegus corusca is perhaps best associated with the *mollis* group, although it differs from the other species of that group which are now known in its firm and very bright and shining leaves and in the absence of tomentum from their lower surface even when young. The flowers, too, are unusually small for a species of that group.

Crataegus Ellwangeriana, n. sp.—Leaves oval, acute, full and rounded or broadly cuneate at the base, irregularly divided usually only above the middle into numerous short acute lobes, coarsely and often doubly serrate, with straight or incurved glandular teeth; in early spring roughened above with short pale hairs and villose below along the slender midribs and primary veins; at maturity membranaceous, dark green and scabrate on the upper surface, pale and nearly glabrous on the lower surface, 2½ to 3½ in. long, 2 to 3 in. wide; petioles slender, nearly terete, at first villose, ultimately nearly glabrous, 1½ to 2 in. long; stipules oblong-obovate, acute, villose, coarsely glandular-serrate, often ½ in. long, those of the upper leaves of fertile branches usually persistent until after the ripening of the fruit. Flowers 1 in. in diameter, on short stout pedicels, in compact compound many-flowered corymbs coated with matted pale hairs; bracts and bractlets lanceolate, coarsely glandular-serrate; calyx-tube broadly obconic, villose, the lobes elongated, lanceolate, glandular, with small pale stipitate glands, villose; stamens 8–10; anthers small, rose-color; styles 3–5. Fruit in drooping villose corymbs, on slender glabrous peduncles ¾ to 1½ in. in length, oblong, full and rounded at the ends, bright crimson, very lustrous, covered particularly toward the ends with scattered pale hairs, ¾ to 1 in. long, ½ to ¾ in. wide; calyx-cavity deep, comparatively narrow, the lobes elongated, glandular-serrate, villose on the upper surface, glandular-serrate above the middle, erect and incurved; flesh thick, yellow, dry and mealy; nutlets 3 to 5, prominently grooved and ridged on the back, ¼ to ⅓ in. long.

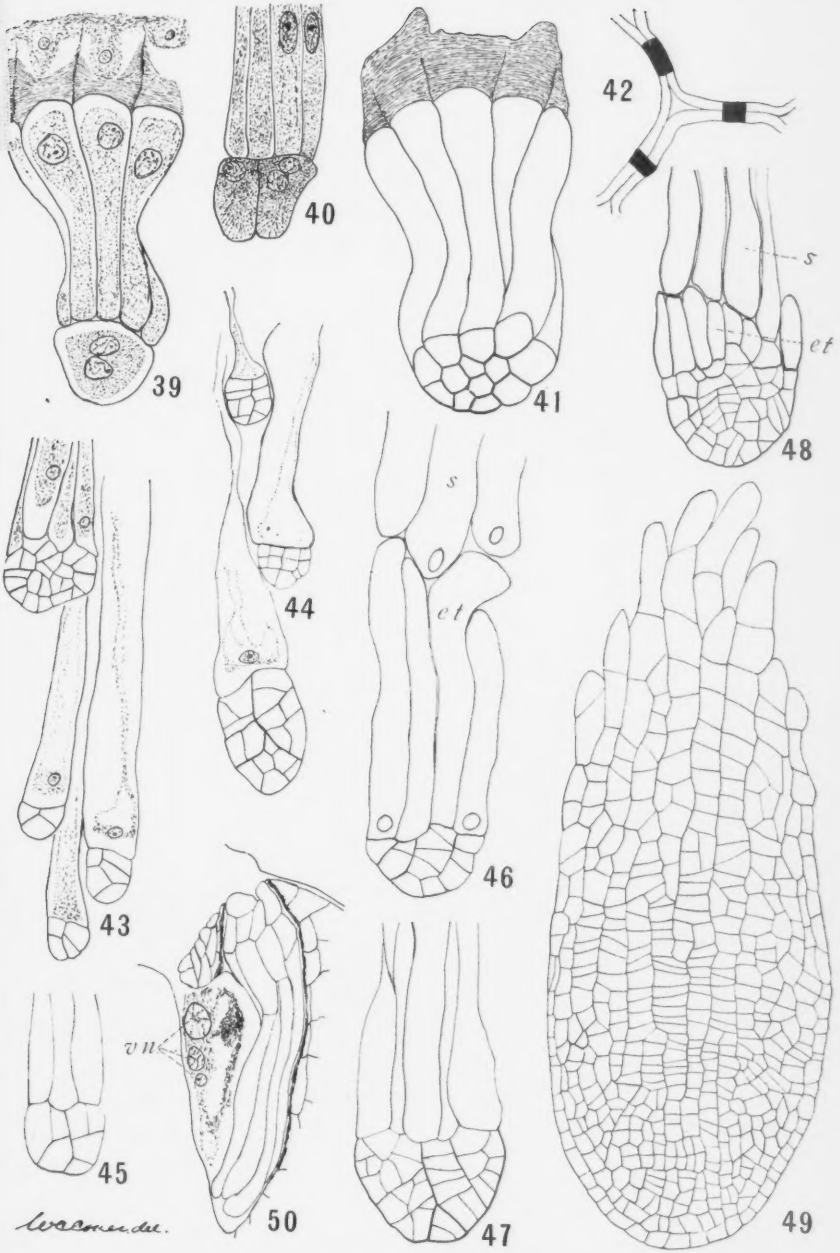
A tree sometimes 25 feet in height with a trunk a foot in diameter covered



COKER on PODOCARPUS



COKER on PODOCARPUS



COKER on PODOCARPUS

with pale gray bark broken into small closely appressed scales and divided 6 or 7 feet above the ground into numerous ascending branches forming a broad symmetrical head, and slender, zigzag branchlets, dark green and coated when they first appear with matted pale hairs, during their first summer slightly villose, light chestnut-brown and marked by occasional small lenticels, chestnut-brown and very lustrous in their second year, and ultimately ashy-gray, and unarmed or armed with stout nearly straight chestnut-brown shining spines usually 1 to 1½ in. long.

Flowers about the middle of May. Fruit ripens and falls from the middle to the end of September.

Near Rochester, N. Y. Common. First distinguished in 1899 by *C. S. Sargent.*

It is a pleasure to associate this handsome and distinct thorn tree, which is one of the largest and most beautiful in the northern states, with the name of Mr. George Ellwanger, the distinguished horticulturist, in whose nurseries at Rochester a tree of this species, still standing, was large enough sixty years ago to be an object of interest and consideration.

Crataegus gemmosa, n. sp.—Leaves broadly oval or rarely broadly obovate, acute or acuminate, gradually narrowed and cuneate or occasionally rounded at the base, sharply and usually doubly serrate from below the middle, with straight glandular teeth, and often slightly lobed toward the apex, with short acute lobes; dark red and villose particularly below as they unfold, almost fully grown when the flowers open and then membranaceous, light yellow-green, nearly glabrous above, pale and villose below; at maturity thick and firm in texture, very dark dull green on the upper surface, pale and pubescent on the lower surface along the stout yellow midribs, deeply impressed and occasionally puberulous on the upper side and along the four or five pairs of slender primary veins running obliquely toward the apex of the leaf, 1½ to 2 in. long, 1 to 2 in. wide; on vigorous leading shoots more coarsely serrate, frequently divided into short lateral lobes, often 4 in. long and 3 in. wide, with rose-colored midribs and stout spreading primary veins; petioles stout, deeply grooved, more or less winged above, villose or pubescent, glandular while young, with minute bright red caducous glands, usually bright pink in the autumn, ¼ to ½ in. long; stipules linear, acuminate, bright red, glandular, caducous,

or on vigorous shoots lunate, acuminate, coarsely glandular-serrate, frequently ¼ in. long. Flowers ½ to ⅔ in. in diameter, in slender branched villose open compound many-flowered corymbs; bracts and bractlets lanceolate to oblanceolate, acuminate, glandular-serrate, conspicuous; calyx-tube narrowly obconic, more or less villose, with matted pale hairs, or nearly glabrous, the lobes lanceolate, acuminate, coarsely glandular-serrate, with bright red glands, glabrous or villose on the outer surface, villose on the inner surface, reflexed after anthesis; stamens 20; anthers, small, rose-color; styles 2 or usually 3, surrounded at the base by a narrow ring of pale tomentum. Fruit on elongated slender pedicels, in drooping many-fruited glabrous or puberulous clusters, subglobose or short-oblong, scarlet, lustrous, ½ in. in diameter when fully ripe; calyx prominent, with an elongated narrow tube, and reflexed villose lobes, bright red toward the base on the upper side; flesh thick, clear yellow, sweet, very succulent; nutlets 2 or 3, ¼ in. long, broad, flat, prominently ridged on the back, with high rounded ridges, penetrated on each of the inner faces by a short broad deep cavity.

A tree occasionally 30 feet in height with a tall trunk 10 or 12 in. in diameter covered with dark brown scaly bark, stout spreading or ascending branches forming a rather broad open symmetrical head, or often shrubby and sometimes flowering when only a few feet high, and with stout glabrous zigzag branchlets marked by numerous oblong pale lenticels, dull orange-green when they first appear, light red-brown or yellow-brown and lustrous for two or three years and ultimately dull red-brown, and armed with straight or slightly curved thick bright chestnut-brown lustrous spines usually about 2 in. in length Winter buds globose, sometimes nearly ¼ in. in diameter, with broad ovate rounded lustrous bright red-brown outer scales pale and scarious on the margins.

Flowers in Ontario and central Michigan from the middle to the end of May. Fruit ripens the first of October.

Near Rochester, N. Y., *John Dunbar*, October, 1901; Humber river flats near Toronto, *D. W. Beadle*, May and September, 1901; London, Ont., *C. S. Sargent*, September, 1901; Belle Isle, Mich., *C. S. Sargent*, September, 1901; Grand Rapids, Mich., *Mrs. C. W. Fallass*, May, 1895, *Miss E. J. Cole*, May, 1896 and 1901, *Miss E. J. Cole*, and *C. S. Sargent*, September, 1901.

Well distinguished from the other species of the *tomentosa* group by its

remarkably large winter buds, by its stout thorns, dark usually broadly oval leaves, and by the size of the fruit, which, with the exception of that of *Crataegus tomentosa*, is smaller than the fruit of the other species of this group whose flowers have twenty stamens.

Crataegus blanda, n. sp.—Leaves oval to rhombic, acute or acuminate, occasionally slightly lobed toward the apex, broadly cuneate or concave cuneate at the entire base. coarsely crenulate-serrate above the middle, with glandular teeth; coated as they unfold with soft pale hairs; fully grown when the flowers open and then glabrous with the exception of large tufts of snow white tomentum in the axils of the primary veins, membranaceous, dark green and lustrous above, 1½ to 2 in. long and 1 to 1½ in. wide; at maturity subcoriaceous, yellow-green and lustrous above, pale below with slender midribs deeply impressed on the upper side and two or three pairs of slender primary veins extending very obliquely toward the apex of the leaf; on leading shoots often broadly ovate, full and rounded at the base, more deeply lobed above the middle, 2 to 2½ in. long, 1½ to 2 in. wide; petioles slender, slightly winged above, villose at first on the upper side, soon glabrous, ¾ to 1 in. long; stipules linear-lanceolate, entire, from ⅓ to ¼ in. long, caducous. Flowers 1 in. in diameter, on slender elongated pedicels, in broad loose many-flowered compound glabrous corymbs; bracts and bractlets linear, entire, caducous; calyx-tube broadly obconic, glabrous, the lobes gradually narrowed from broad bases, acuminate, entire or obscurely dentate, glabrous, reflexed after anthesis; stamens 20; anthers small, canary-yellow; styles 5. Fruit in many-fruited drooping clusters, subglobose to short-oblong, bright orange-red, marked by few pale lenticels, ¼ in. in diameter; calyx prominent, with a broad deep cavity and spreading lobes mostly deciduous before the ripening of the fruit; flesh thin, yellow, dry and mealy; nutlets 5, thin, pale brown, deeply grooved on the back, $\frac{3}{16}$ in. long.

A tree 25 or 30 feet in height with a tall trunk 10 or 12 in. in diameter covered with dark brown or nearly black fissured scaly bark, stout ascending branches forming a broad open irregular head, and nearly straight slender unarmed glabrous branchlets marked by large pale scattered lenticels, at

first dark orange-green, becoming dull red-brown during their first season and darker brown in their second year.

Flowers the first of May. Fruit ripens about the middle of October.

Dry hills near Fulton, Arkansas. Common. *B. F. Bush*, April 29, and October 15, 1901 (nos. 601, 1079).

This very distinct thorn belongs to a group of small-fruited still very imperfectly known species which is abundant with several forms in southern Arkansas, Louisiana, and Texas, and of which *Crataegus viridis* of Linnaeus is the type. From that species *Crataegus blanda* differs in the character and color of the bark, in the larger flowers and fruit, in the unarmed branches, and in its preference for dry uplands, *Crataegus viridis* with pale nearly white bark being found usually only on low moist bottom-lands along the borders of streams and swamps.

Crataegus Ravenelii, n. sp.— Leaves obovate, rounded and abruptly short-pointed or acute at the broad sometimes slightly lobed apex, gradually narrowed from above the middle to the cuneate elongated undulate glandular base, 3-nerved, coarsely and usually doubly glandular-serrate above, with large bright red ultimately dark persistent glands; nearly fully grown when the flowers open and then coated with long scattered matted pale hairs; at maturity thin but firm in texture, yellow-green, scabrate on the upper surface, pubescent on the lower surface along the slender nerves, 1 to 1½ in. long, about ¾ in. wide; on vigorous leading shoots often 2 in. long and 1½ in. wide, and divided above the middle into two or three pairs of broad lateral lobes; petioles slender, winged above by the decurrent bases of the leaf-blades, conspicuously glandular, tomentose at first, ultimately pubescent, from ¼ to ½ in. long; stipules linear to lunate, coarsely glandular-serrate, tomentose, caducous. Flowers about ¾ in. in diameter, in few or many-flowered simple tomentose corymbs; bracts and bractlets linear, glandular, caducous; calyx-tube narrowly obconic, thickly coated with long white hairs, the lobes lanceolate, villose on the outer surface, glabrous on the inner surface, glandular with small red glands, reflexed after anthesis; stamens 20, anthers small, pale yellow; styles 5, surrounded at the base by a broad ring of pale tomentum. Fruit in few-fruited puberulous spreading or drooping clusters, on short thick peduncles, globose or short-oblong, bright orange-red,

marked by occasional large dark lenticels, puberulous at the ends, ⅓ to ½ in. in diameter; calyx prominent, with a broad shallow cavity and enlarged spreading and appressed lobes; flesh thick, yellow, subacid; nutlets 5, ridged on the back with narrow elevated ridges, pale brown, ¼ in. long.

A tree 25 to 30 feet in height with a trunk 14 or 15 in. in diameter covered with thick dark brown bark deeply divided into narrow interrupted ridges broken on the surface into short thick plate-like scales, stout spreading and ascending branches forming a broad open irregular head, and thick slightly zigzag branchlets coated with hoary tomentum when they first appear, dark purple or reddish-brown and pubescent during their first summer, dark gray-brown and glabrous the following season, and armed with straight stout dull gray-brown spines usually about 1½ in. long.

Flowers about the middle of April. Fruit ripens early in October.

Sandhills west of Augusta, Georgia, and Aiken, South Carolina.

Long confounded with *Crataegus flava* of Aiton, *Crataegus Ravenelii* differs from that species in the form of the leaves, the size of the flowers, the color of the anthers, and the size and character of the fruit. The oldest specimens which I have seen were collected near Aiken in 1880 by Henry William Ravenel, and the name of that distinguished South Carolina botanist may therefore fittingly be associated with this handsome thorn tree.

Crataegus lacera, n. sp.—Leaves rhombic to broadly ovate or rarely obovate, acute at the apex, broadly cuneate and entire at the base, divided above the middle into numerous narrow acuminate lobes, coarsely and often doubly serrate with straight glandular teeth; coated below as they unfold with thick hoary tomentum and villose above; nearly fully grown when the flowers open and then glabrous below and covered above with short scattered pale hairs; at maturity yellow-green, darker on the upper than on the lower surface, glabrous, thin but firm in texture, about 1½ in. long and 1¼ in. wide, with slender yellow midribs and few remote primary veins only slightly impressed above; on vigorous leading shoots usually broadly ovate, often deeply three-lobed, very coarsely serrate, 3 to 4 in. long and broad; petioles slender, grooved, villose, ultimately glabrous or puberulous, narrowly wing-margined above, often red toward the base, ¼ to ⅓ in. long; stipules linear, acuminate, villose, caducous; on vigorous shoots lunate, long-pointed, coarsely

glandular-serrate, villose, sometimes ¼ in. long. Flowers ¾ in. in diameter, in sparingly villose many-flowered compound corymbs; bracts and bractlets linear, caducous; calyx-tube narrowly obconic, glabrous, the lobes linear-lanceolate, elongated, coarsely glandular-serrate, glabrous on the outer surface, villose on the inner surface, reflexed after anthesis; stamens 20; anthers small, rose-color; styles 3 to 5. Fruit on short stout glabrous peduncles in erect few-fruited clusters, oblong, full and rounded at the ends, bright cherry red, lustrous, marked by occasional large dark lenticels, ½ in. long; calyx-cavity broad and shallow, the lobes small, nearly triangular, villose on the upper surface, mostly deciduous before the ripening of the fruit; flesh thick, orange-colored; nutlets 3 to 5, thin, broad, only slightly ridged on the rounded back, with low rounded ridges, light brown, $\frac{5}{16}$ in. long.

A slender tree 25 to 30 feet in height with a tall trunk occasionally 4 or 5 in. in diameter covered with pale gray-brown scaly bark, small spreading branches forming a narrow head, and slender slightly zigzag branchlets marked by small oblong scattered pale lenticels, dark olive green and villose when they first appear, light red-brown during their first summer and ultimately dull light gray, and armed with occasional slender straight bright chestnut-brown lustrous spines ¾ to 1¼ in. long.

Flowers about April 20th. Fruit ripens the middle of October.

Low rich woods near Fulton, Arkansas. Rare. *C. S. Sargent*, October 2, 1900, *W. M. Canby*, *B. F. Bush*, and *C. S. Sargent*, April 23, 1901, *B. F. Bush*, August and October, 1901.

This very distinct and handsome thorn somewhat resembles, in the structure of the flowers and in the form and lobing of many of the leaves, *Crataegus apiifolia*, from which, however, it differs in the usual form of the leaves and in the character of the fruit.

Crataegus Floridana, n. sp. (*Crataegus flava*, Sargent, *Silva N. Am.* 4: 13. 1892, in part [not Aiton]).—Leaves obovate-cuneate, frequently 3-lobed at the apex, with short rounded lobes, gradually narrowed and cuneate at the entire base, finely serrate above, with straight or incurved glandular teeth, 3-nerved, with numerous thin secondary veins and reticulate veinlets; slightly villose above as they unfold, nearly fully grown when the flowers open and then light yellow-green, villose only

along the nerves and in their axils; in the autumn thick and firm, dark green and lustrous on the upper surface, pale on the lower surface, 1 to 1½ in. long and about ½ in. wide; petioles wing-margined above, glandular, tomentose, ultimately pubescent or glabrous, usually about ½ in. long; the leaves on leading shoots frequently 2 in. long and 1 in. wide, and sometimes divided by deep rounded sinuses into numerous lateral lobes. Flowers ⅝ in. in diameter, in few usually 3-flowered simple compact tomentose cymes: bracts and bractlets linear-lanceolate or oblanceolate, glandular, caducous; calyx-tube broadly obconic, coated with matted pale hairs, the lobes narrow, acuminate, glandular, villose toward the base on the outer surface and on the inner surface, reflexed after anthesis; stamens 20; anthers pale yellow; styles 4 or usually 5, surrounded at the base by a broad ring of shining white hairs. Fruit solitary or in 2- or 3-fruited drooping clusters, on short stout pubescent peduncles, obovate, bright orange-red, usually about ¾ in. long; calyx prominent with a broad elongated tube and reflexed glandular-serrate lobes; flesh thin, dry and mealy; nutlets 4 or 5, slightly ridged on the back, ⅓ in. long.

A tree, rarely more than 15 feet in height, with a tall straight trunk 6 or 8 in. in diameter covered with thick nearly black deeply furrowed bark broken into short thick plate-like scales, small drooping branches forming a handsome symmetrical head, and slender conspicuously zigzag pendulous branchlets coated when they first appear with long matted hairs, dark red-brown and more or less villose during their first season, dull dark brown the following summer, and armed with long slender straight spines, or unarmed.

Flowers the middle of March. Fruit ripens from the middle to the end of August.

Sand-barrens of northeastern Florida and probably northward along the coast of Georgia.

Jamaica Plain, Mass.

A DESCRIPTIVE LIST OF THE PLANTS COLLECTED BY DR. F. E. BLAISDELL AT NOME CITY, ALASKA.

ALICE EASTWOOD.

(WITH TEN FIGURES)

THE plants forming the subject of this paper were collected at Nome city during the flowering season of 1900. This place has lately come into prominence on account of the valuable gold diggings located there, and is now visited annually by many people. On this account it seems well to publish a list of the plants found there, in order to give to others an idea of the flora, and also to assist botanists there who have at present no means of identifying the plants that bloom so profusely during the short summer. A mere list of names is of little value except to the worker in the herbarium, but a descriptive list, supplemented by a knowledge of orders and genera, or by some book in which these are given, will lead to the identification of almost all the species.

The Pteridophytes, Gramineae, Cyperaceae, Juncaceae, and Salicaceae have been determined by eminent authorities, and except in the last I have simply given the lists as they were given to me in each instance. It is with gratitude for this and other favors that I here acknowledge my obligations to my botanical friends.

The interesting description of the country which has been written by Dr. Blaisdell gives an excellent idea of the environment. Except in a few instances, where the environment has been especially noted, the plants were all collected in the tundra and within a radius of a few miles of Nome city.

THE VICINITY OF NOME CITY.[1]

Nome city is situated on the seacoast at the edge of the tundra. The latter extends inland, rising uniformly about two

[1] Written by Dr. F. E. Blaisdell.

hundred feet in four or five miles, where it becomes broken up and forms the rounded slopes of the hills and small mountains, which in the vicinity of Anvil mountain do not reach an altitude of more than 400 to 1000 feet. In this particular region the easterly slopes of this mountain and adjoining hills form the divide between the tributaries of the Nome river, that flow in an easterly direction, and those of the Snake river, that flow south-

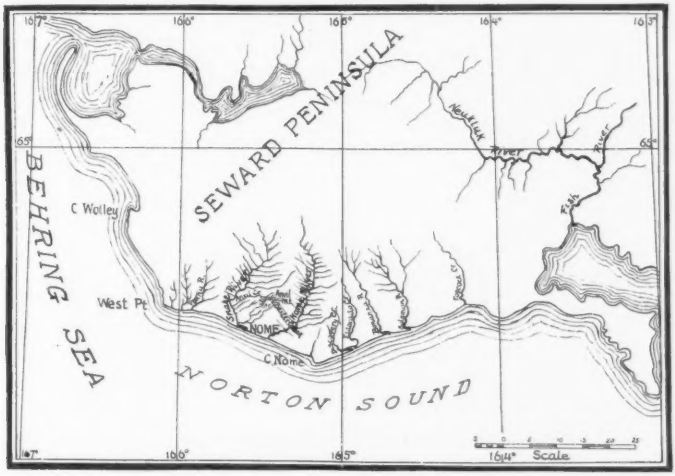


FIG. 1.— MAP, showing region where a botanical collection was made by F. E. Blaisdell, M.D.

westerly. Dexter creek is one of the large creeks of this vicinity that empty into the Nome river, and has its origin in the easterly slopes of Anvil mountain and the neighboring hills, six miles north of Nome city, and courses two and a half miles eastward to the Nome river. The highest peak in this region is King mountain (so called in the neighborhood), situated between Dexter creek on the southeast and Anvil creek on the west; also between Anvil mountain on the south and Nome river on the east.

The tundra is truly a marshy plain from its commencement at the seashore to the highest mountain, although the latter by

its altitude is more quickly drained, and becomes comparatively dry earlier in the season. It is roughened by hummocks of moss and bunch grass varying from a few inches to two feet high, and in circumference from that of a stove-pipe in the marshiest places to the broad, flattened, and rounded knolls of the general surface. In the crevices between the hummocks, which may be narrow and deep or shallow and varying in breadth, little streams of various sizes trickle along, working their way to the larger creeks. Here and there are perennial springs. Most of the water that flows from the tundra comes from the thawing of the subterranean ice, and the small glaciers that remain in the higher valleys after the snow disappears. These endure the entire season unless the summer is unusually warm. As the season advances and the ice and snow gradually disappear, the smaller streamlets dry up, so that in the month of August the land is comparatively dry. More or less rain falls during the summer. Some seasons are very rainy, as the summer of 1899, while that of 1900 was dry. Near the end of the month of July, I found ice six inches beneath the surface of the ground. This formed the floor of a ground squirrel's burrow which I explored.

Everywhere the ground is covered with mosses, lichens, and prostrate plants, the mat varying in thickness from one to several inches. Within the small crevices between the hummocks grow many of the small plants. The willows are the largest shrubs of the region, on the tundra being from two to three feet high, but along the rivers attaining a height of eight or more feet. They are scattered here and there, or form thickets an acre or less in extent. Many species of plants find a home in the shelter of these thickets.

I could make out but two or three life-zones in this region. That over which I collected may be bounded as follows: on the south by the seacoast at Nome city; on the west by Snake river and its tributary, Glacier creek; on the east by Nome river; on the north by Boston and Grouse creeks, tributaries of Glacier creek and Nome river. In the lower zone the several species of plants have a general distribution, an aggregation of individuals

of a species occurring here and there where the conditions are more favorable to their growth. In the upper zone, above four hundred feet altitude as an approximate lower limit, a number of species occur that were not to be found on the lower levels. The general conditions are about the same in both zones. Altitude and dryness from the earlier drying up of the excess of water, and rocky ledges attracting the sun's rays, are the main differences in environment observed in the upper zone.

When I landed, June 18, the anemones and primroses were blooming, and many willows were unfolding their catkins. All species had almost finished blooming by the end of August, when the first frosts terminated plant activity, and by the middle of September everything was frozen up.

The following list includes all the species I saw except one species of Allium, one of Veratrum, one of Aquilegia, and one of Delphinium. There were also some mosses and lichens that have not yet been determined.

FILICES.[1]

1. DRYOPTERIS FRAGRANS (L.) Schott.
2. FILIX FRAGILIS (L.) Underw.
3. FILIX MONTANA (Lam.) Underw.
4. GYMNOPTERIS TRIANGULARIS (Kaulf.) Underw.
5. PHEGOPTERIS PHEGOPTERIS (L.) Underw.

EQUISETACEAE.[2]

6. EQUISETUM PRATENSE Ehrh.
7. EQUISETUM VARIEGATUM Schleich.

LYCOPODIACEAE.[2]

8. LYCOPODIUM ALPINUM L.
9. LYCOPODIUM ANNOTINUM L. The so-called var. pungens.
10. LYCOPODIUM SELAGO L.

[1] Determined by L. M. Underwood.

GRAMINEAE.[3]

11. ALOPECURUS ALPINUS J. E. Smith.
12. ARCTOGROSTIS LATIFOLIA Griseb.
13. BROMUS PACIFICUS Shear. A very much reduced form, possibly already published under some older and as yet unidentified name.
14. ELYMUS MOLLIS Trin.
15. POA ALPINA L.
16. POA ARCTICA R. Br.
17. SAVASTANA ALPINA (Sw.) Scribn.

CYPERACEAE.[4]

18. CAREX CAPITATA L.
19. CAREX COMPACTA R. Br.
20. CAREX LAGOPINA Wahl.
21. CAREX MACROCHAETA C. A. Meyer.
22. CAREX MISANDRA R. Br.
23. CAREX RIGIDA Good.
24. CAREX SCIRPOIDES Mx.
25. ERIOPHORUM ANGUSTIFOLIUM Roth.
26. ERIOPHORUM VAGINATUM L.

JUNCACEAE.[5]

27. JUNCOIDES CAMPESTRE SUDETICUM (Willd.) Coville.
28. JUNCOIDES PARVIFLORUM (Ehrh.) Coville.
29. JUNCOIDES SP.
30. JUNCUS CASTANEUS Smith.
31. JUNCUS HAENKEI E. Mey.

LILIACEAE.

32. LLOYDIA SEROTINA Sweet Hort. Brit. ed. II. 527.—*Anthericum serotinum* L. Sp. pl. ed. 2. 444. 1762; *L. alpina* Salisb. Trans. Hort. Soc. 1: 328. 1812.—The small bulb or corm is concealed by the scarious bases of former leaves which also

[3] Determined by F. Lamson-Scribner.

[4] Determined by Theodor Holm. [5] Determined by F. V. Coville.

sheath the lower part of the present leaves and the flowering stem: leaves filiform, 9–12^{cm} long, longer or shorter than the stem; cauline leaves generally 3, clasping at base and dilated, involute: flowers solitary, erect, terminating the stem: perianth with the divisions 3-nerved, oblanceolate, obtuse, incurved at base: stamens half as long as the perianth (5^{mm}), with flattened subulate filaments and elliptical basifixed anthers: capsule when ripe shorter than the marcescent perianth, angled; the valves obcordate at apex, cuneate at base, cuneate-obovate in general outline. The flowers are like small erect lilies, dull white, veined with green or purplish lines.

Type range: "in alpibus Angliae, Helvetiae, Taureri rastadiensis, Wallaesiae."

33. TOFIELDIA PALUSTRIS Huds. Fl. Angl. ed. II. 1: 175. 1778.— *T. borealis* Wahl. Fl. Lapp. 89. 1812.— Roots fibrous: leaves tufted at base, erect, equitant, linear-acuminate, about 2^{cm} long, 1^{mm} wide, with three prominent nerves: scape naked or with one leaf near the base, 8–15^{cm} high: raceme short, less than 3^{cm} long, densely flowered; pedicels short, 1–2^{mm}, with three very short papery bracts at base: perianth marcescent, shorter than the ripe capsule, which is elliptical-orbicular, tipped by the short stout divergent styles with capitate stigmas: seeds many, ellipsoidal, appendaged by the funiculus.

34. ZYGADENUS ELEGANS Pursh. Fl. Am. Sept. 1: 241. 1813.— *Z. glaucus* Nutt. Journ. Acad. Philad. 7: 56. 1834.—Stem about 3^{dm} high from a coated bulb, glaucous and glabrous: leaves mostly basal, grass-like, usually one or two on the stem: flowers racemose, distant on the lower part of the stem, closer near the summit; bracts exceeding the pedicels, 1–2^{cm} long, scarious: flower 15–20^{mm} in diameter: segments of the perianth whitish, veined with green; inner ones with well-marked claw; outer ones broader, narrowed to the base; gland yellow above the claw, deeply emarginate: filaments shorter than the perianth.

Type locality: "on the waters of Cokahlaishkit river, near the Rocky mountains.— M. Lewis."

IRIDACEAE.

35. **Iris arctica,** n. sp.—Rhizome stout, oblique, clothed with brown sheaths which are split into fibers: leaves erect, thin, lax, 2–2.5^{dm} long, 5–8^{mm} broad, acuminate, veiny; young leaves rosy at base: stem almost twice as long as the leaves, simple, with one or two leaves, the top leaf rarely reaching the spathe: spathes one-flowered; outer bract leaf-like, acuminate, 3–6^{cm} long, shorter than or surpassing the pedicels; the two inner thinner, acute: pedicels scarcely exserted beyond the spathes in flower, 3–5^{cm} long in fruit: tube of the perianth cylindraceous, 5^{mm} long, 2^{mm} in diameter; falls widely spreading, with claw 2.3^{cm} long, 1^{cm} broad at top, narrowed at base, blade ovate orbicular, violet with a greenish-yellow spot where it joins the claw, 3.5^{cm} long, almost 4^{cm} broad, veiny; standards inconspicuous, variously shaped, generally ovate with a sort of lobe at top surmounted with a long setaceous appendage, the much broader lower part, corresponding to the claw, white blotched with purple on the lower half: style branches 3^{cm} long; crests generally entire and straight on the inner side, laciniate-dentate on the outer, oblong in general outline, veiny; stigma deltoid: stamens with filaments as broad as the anthers and a little longer, the latter 1^{cm} long: ovary 3-sided, narrowed at the two ends: immature capsule ellipsoidal.

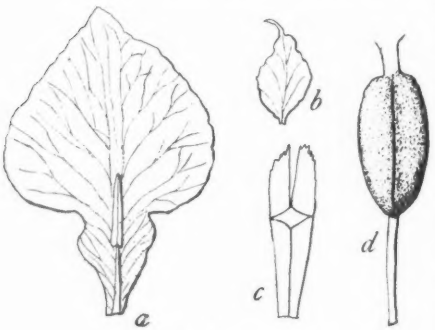


FIG. 2.—IRIS ARCTICA, n. sp. *a*, blade; *b*, standard; *c*, style branch; *d*, ovary. All three-fourths nat. size.

This is nearest to *Iris setosa* Pallas, from which it differs in having simple stems and one-flowered spathes, and especially in the shape of the divisions of the flower. It resembles this and other allied species in having the standards inconspicuous and very much smaller than the falls. The description of *Iris setosa* has been taken from Baker's *Irideae*, p. 11, also from Ledeb. *Fl. Ross.* 4: 96. the original reference.

SALICACEAE.[6]

36. SALIX ALAXENSIS Coville, Proc. Wash. Acad. Sci. **2**: 280 1900; *idem* **3**: 311. *pl. 34*. 1901.—*S. speciosa* Hook. & Arn Bot. Beech. 130. 1832; *S. speciosa alaxensis* Anders. DC. Prod. **16**[2]: 275. 1868.—Stems rather stout, densely white-tomentose or flavescent: leaves obovate to oblong-lanceolate, acute or acuminate, densely tomentose on the lower surface, glabrous or with some woolly hairs on the upper; the largest leaves 5.5[cm] long, 2–5[cm] wide; petioles 5[mm] long, shorter than the linear-lanceolate stipules; these 5–10[mm] long, white-woolly: female catkins 6[cm] long, the bracts black, clothed with long white woolly hairs: style long; stigma with linear two-parted lobes: capsules ovate-acuminate, sessile, clothed with silky hairs.

Type locality: "Alaxa Americae occidentali-borealis." On the banks of Nome river.

37. SALIX CHAMISSONIS Anders. DC. Prod. **16**[2]: 290. 1868.—Stems shining, chestnut-brown: leaves (in bud) glandular-serrate, green on the upper surface, glaucescent and somewhat lanate on the lower; petioles short, about as long as the gland-toothed stipules: catkins with leafy peduncles, densely flowered, 3–5[cm] long; scales black, clothed with long white silky hairs that almost equal the capillary filaments but are shorter than the styles: capsules clothed with sparse short white pubescence, tapering at apex to the long black style; divisions of the stigma short with the lobes as long.

Type locality: "in sinu *S. Laurentii*."

38. SALIX GLAUCA L. Sp. Pl. 1019. 1753.—Old stems chestnut-brown, young ones white-tomentose: leaves elliptical, subovate, acute, tapering to a short petiole which is 5[mm] long, generally surpassed by the white-woolly stipules, upper surface green, lower glaucous, clothed with fine silky hairs which are more abundant on the lower surface than the upper; longest leaf 4[cm] long, 12[mm] broad: catkins small, subtended by the leaves, 1.5[cm] long; scales arranged in whorls 1[mm] apart, orbicular,

[6] Determined by F. V. Coville.

brown or black, white hairy: stamens 2 from each scale, with filaments 5^{mm} long.

Type locality: "in Alpibus Lapponicis and Pyrenaicis."

39. SALIX PHLEBOPHYLLA Anders. Oefv. Kongl. Vet. Akad. Foerh. **15**: 131. 1858.—About 2^{cm} high, from branched woody prostrate stems: leaves crowded on short petioles, ovate-orbicular, glossy, veiny, green on both sides but with some long loose woolly hairs on the lower surface, 1^{cm} long, 7^{mm} wide, with obtuse apex and revolute margin; old leaves persisting and becoming skeletonized: catkins (female only) about 1^{cm} long, surrounded by leaves at base; scales black, orbicular, clothed with long white wool: styles purplish, about equaling the woolly hairs of the scales; stigma with each division two-lobed.

40. SALIX PULCHRA Cham. Linnaea **6**: 543. 1831.—Stems dark brown, glossy: leaves (immature) glabrous or slightly villous, sparingly glandular-serrate; stipules linear-lanceolate, green on the upper surface, glaucescent on the lower: peduncles short, not leafy, but with one or two black scales at base: catkins oblong-elliptical, 2^{cm} long; scales black-lanate but not densely so; female catkin with long yellow styles and stigmas twice-lobed: capsules ovate-acuminate, slightly hispid.

Type locality: "in Promontorio Espenbergii Americae transbeeringiensis, inque insula Sti. Laurentii."

41. SALIX RETICULATA L. Sp. Pl. 1018. 1753.—Stems 5–10^{cm} high, brown, prostrate, woody: leaves elliptical, ovate or orbicular, generally obtuse, green and glabrous on the upper surface, glaucous and villous on the lower, beautifully reticulate-veiny on both sides, 1–3.5^{cm} long, 1–2.5^{cm} wide, petioles half to two-thirds as long as the blade, reddish: peduncles longer than or equaling the catkins, which are slender, 1.5–3^{cm} long: male catkins with bracts subverticillate, reddish, pubescent and densely ciliate with short white hairs; filaments two to each bract, 2^{mm} long: female catkins more closely flowered, and the bracts almost glabrous: capsules sessile, tomentose, ovate-acuminate, 4^{mm} long; styles less than 1^{mm} long; stigma with the two short divisions each two-cleft.

Type range: "in Alpibus Lapponiae, Helvetiae." Collected on Mt. King.

42. SALIX sp.—Stems glabrous or slightly pubescent: leaves elliptical, acute or obtuse at apex, bright green on the upper side, glaucous on the lower, with margin entire or sparingly glandular-toothed; largest leaf 6.5^{cm} long, 3^{cm} broad; petioles 1–3^{mm} long; stipules only on the younger leaves, ovate, glandular-toothed, about as long as the petioles: catkins 2^{cm} long, loosely flowered, on short leafy peduncles; bracts oblong, brown with silky wool at apex: capsules on short pedicels, ovate-lanceolate, acuminate, 4^{mm} long; styles short; stigmas capitate at first, later two-lobed.

This is an undetermined species which Mr. Colville writes has been collected also at other places.

BETULACEAE.

43. BETULA NANA L. Sp. Pl. ed. 2. 1394. 1763; Fl. Lapp. 274. *pl. 6. fig. 4.*—Low shrub with brown bark, white dotted: leaves small, orbicular, 5–10^{mm} wide, irregularly dentate, with petioles 2^{mm} long.

Type range: "in Alpibus Lapponicis, paludibus Sueciae, Russiae."

The specimen is without flowers or fruit. The catkins are described as small.

POLYGONACEAE.

44. OXYRIA DIGYNA Hill Hort. Kew. 158. 1765 (ex Index Kewensis).—Stems erect, 2–2.5^{dm} high, with branched inflorescence: radical leaves orbicular-reniform, glabrous, on long petioles: flowers on slender pedicels, several from each scaly bract, drooping; sepals four, two appressed to the fruit, the other two-spreading, carinate on the back: fruit orbicular, red-winged: stigmas two, tufted at the deeply emarginate apex.

45. POLYGONUM BISTORTOIDES Pursh. Fl. Am. Sept. 271 1814.—Stems erect, 2^{dm} high, from thick rootstocks: radical leaves oblong, 3–5^{cm} long, smooth and deep green on the upper surface, pale green on the lower, margin crisped-undulate and disposed to be revolute; sheaths not jointed to the petiole, oblique at top, surpassing the petiole of the cauline leaves: flowers white, turning pink, on slender pedicels, in a dense racemose spike, 3^{cm} long, 2^{cm} wide: stamens with white filaments and violet

anthers, exserted together with the style, twice as long as the perianth: bracts brown, scarious.

Type locality: "in low grounds on the banks of the Missouri, called Quamash-flats. M. Lewis." Too young for fruit.

46. POLYGONUM VIVIPARUM L. Sp. Pl. 360. 1753.—Stems erect from a bulb-like rootstock: radical leaves oblong to lanceolate, or sometimes ovate-cordate, dark green and glabrous above, glaucous and sparsely pubescent below, tapering at both ends, 3–4^{cm} long, 3–6^{mm} wide; petioles about as long as the blades; stem leaves strongly revolute, with the brown sheaths longer than the petioles: spicate raceme linear-oblong, 4–5^{cm} long, including the bulb-bearing lower half: stamens almost twice as long as the perianth, with filaments longer than the styles, and anthers dark purple.

Type range: "in Europae subalpinis pascuis duris."

47. RUMEX ACETOSA L. Sp. Pl. 337. 1753.—Dioecious: stem erect, ribbed, 4–5^{dm} high, glabrous throughout: leaves few, ovate, auriculate or sagittate at base, acute or obtuse at apex, 2–3^{cm} long; sheaths about as long as the broad petioles on the cauline leaves, much shorter on the radical: flowers panicled; pedicels jointed in the middle; perianth divisions reflexed; fruiting bracts ovate, veiny, reddish, without grains on the back, but with a scale at base: seeds wing-angled.

Type range: "in Europae pascuis."

48. RUMEX sp.—Stems 2–3^{dm} high, rather stout, glabrous, red or green, striate, from a thick root: radical leaves narrowly oblong on broad petioles, usually cordate at base, obtuse at apex: cauline leaves one or two, with sheaths as long as the petioles, often with crisped margins: panicle thyrsiform or virgate; flowers drooping on slender pedicels, hermaphrodite: stamens exserted: valves of the immature fruit oblong, without grains or scales.

Too immature for determination, but it seems to be near *R. occidentalis nanus* Trelease, Rep. Mo. Bot. Gard. 3: 82. 1892.

PORTULACACEAE.

49. CLAYTONIA TUBEROSA Pall. ex Willd. in Roem. & Schult. Syst. **5**: 436. 1819.—Stems slender with two lanceolate leaves, opposite or alternate, 1–2 cm below the inflorescence: these leaves about 2 cm long, narrowed at base, sessile, obtuse at apex, glabrous: flowers umbellately panicled, with pedicels recurved in fruit, 1–2 cm long; bracts red, sheathing or wanting on all except the lowest: calyx of two broad, ovate, accrescent sepals: petals white, 1 cm long, more than twice as long as the sepals, 6 cm broad, truncate or slightly emarginate at apex: filaments dilated at base, half as long as the petals; anthers pink, narrowly oblong: seeds not ripe.

The specimens at hand are without radical leaves or roots, but seem to agree with this species as described in Gray's *Syn. Fl.* **1**: 272.

50. MONTIA SARMENTOSA Robinson, Syn. Fl. N. Am. **1**: 272. 1897.—*Claytonia sarmentosa* C. A. Meyer, Mém. Soc. Nat. Mosc. **7**: 137. *pl. 3*. 1829.—Stems glabrous, from slender running roots, producing runners: radical leaves on long margined petioles, obovate or ovate; cauline leaves ovate, sessile, clasping: flowers racemose with recurved pedicels, without bracts: sepals broadly ovate, slightly surpassed by the capsule: petals pink or white, 1 cm long, 5 mm wide, thrice as long as the sepals, with a distinct claw and obcordate blade: seeds two or three, shining, black, granulate mucronulate.

CARYOPHYLLACEAE.

51. ARENARIA ARCTICA Stev. DC. Prod. **1**: 404. 1824; Cham. & Schl. Linnaea **1**: 54. 1826; Hook. Fl. Bor.-Am. *pl. 34 B*.—Stems tufted-cespitose, glandular: lowest leaves closely imbricated in bunches, glabrous, linear, obtuse, apparently fleshy, somewhat falcate, 5 mm long, the margin without cilia: stems 2–3 cm high, with a pair of ovate obtuse membranously-margined slightly ciliate connate-clasping leaves about 1 cm distant from the flower: calyx green or purplish, with the divisions ovate, 4 mm long, obscurely nerved, the margins membranous, purplish or white, the apex somewhat incurved but not cucullate: petals

broadly obovate, a little more than 7 mm long, 5 mm broad, tapering to a short yellow claw: filaments flat, slightly surpassing the sepals, abruptly dilated at the very base and thickened: ovary ovoid, obtuse, 2–5 mm long, a little longer than the styles.

Type range: "in littore Sibirico maris glacialis."

52. ARENARIA LATERIFLORA L. Sp. Pl. 423. 1753.—Stems slender, weak, 4 cm high: leaves elliptic-oblong to oval, 5–10 mm long, finely ciliate on the margin, papillose-roughened on the surface: flowers on slender peduncles, surpassing the leaves: sepals suborbicular, 1 mm long, one-nerved, with white membranous margins: petals white, twice as long as the sepals: capsule globular.

Type range: "in Siberia." Only one specimen obtained, and it was one-flowered.

53. ARENARIA MACROCARPA Pursh. Fl. Am. Sept. 1: 318. 1813; Cham. & Schl. Linnaea 1: 54. 1826; Hook. Fl. Bor.-Am. *pl. 34 A*.—Stems matted-cespitose, densely clothed with imbricated leaves, all except the terminal tuft dry and bleached: leaves linear, obtuse, denticulate, falcate, 6 mm long: flowering stems 2–3 cm high, glandular, slender, with one or two pairs of leaves, one-flowered with the peduncle half as long as the stem: stem-leaves shorter and broader than the basal leaves, connate-clasping, glandular: sepals obscurely 3-nerved, linear, 7 mm long, membranously purple- or white-margined, incurved at apex but scarcely cucullate: petals white, oval-obovate, more than 3 cm long, 5 mm broad: stamens with flat filaments widening gradually to the base where they become fleshy and suddenly dilated, surpassing the sepals: ovary ovoid, obtuse, 6 mm long, scabrous along the edges of the valves.

Type range: "on the northwest coast of America.—Nelson." The ripe capsule is not present on any of the specimens.

54. ARENARIA PHYSODES Fisch. DC. Prod. 1: 413. 1824.—*Merckia physodes* Fisch. Linnaea 1: 59. 1826.—Stems branching from weak decumbent basal stems, rooting at the joints and somewhat clothed with persistent dead leaves, growing to a height of about 5 cm, glandular-hirsute and ribbed: leaves broadly

ovate to suborbicular, 5–10^{mm} long, cuspidate; petioles very short and broad, a little shorter than the internodes, margins ciliate: flowers at first solitary, later with a second flower from the axil of the top pair of leaves; peduncles 1^{cm} long, glandular like the stem: sepals ovate to oval, acute or obtuse, 5^{mm} long, 3^{mm} wide, the margin purple, sparingly glandular-hairy: petals with short yellow claws and broad white ovate-orbicular blades, together a little longer than the sepals: capsule depressed-globose, inflated, surpassing the calyx and corolla when ripe, 6–7^{mm} in diameter: styles three, persistent.

Type locality: "in Kamschatka."

55. ARENARIA ROSSII Richardson. R. Br. in Parry 1st Voy. App. 272. 1823.—Matted cespitose: lowest leaves imbricated, the upper pairs more distant, glabrous, linear, three-sided, somewhat fleshy, 4^{mm} long: peduncles capillary, erect-spreading or slightly curved at tip, 2–4^{mm} long: sepals ovate, acute, about 2^{mm} long, gibbous, with the apex involute, membranously margined with white or purple: petals linear to oblanceolate, 2.5^{mm} long, truncate or obtuse at apex: stamens 10, with the alternate filaments about equaling the sepals: filaments from a yellow, fleshy, shield-shaped, five-lobed disk at base of ovary: anthers orbicular, retuse at each end: capsule sessile, conical, five-angled, purplish, tipped by the three styles.

Type locality: "Melville island." In *Index Kewensis* this is made a synonym of *A. stricta* Michx.

56. CERASTIUM ALPINUM FISCHERIANUM Torr. & Gray Fl. 1:188. 1838.—*C. Fischerianum* Seringe, DC. Prod. 1:419. 1824.—Stems 1.5–2^{dm} high, villous pubescent below, glandular above: leaves lanceolate-acuminate, 10–15^{mm} long, 2–4^{mm} wide: flowers cymosely panicled: peduncles 1–2^{cm} long: petals twice as long as the sepals, 1^{cm}: pod exserted from the calyx 5–6^{mm}.

Type locality: "in Kamschatka."

57. CERASTIUM VULGATUM L. Spec. Pl. ed. 2. 627. 1762.—Lower part of stem pilose, upper viscid-pubescent: leaves in pairs, distant, oblong, 10–15^{mm} long, pilose: flowers capitate-cymose, the upper pair of leaves subtending the inflorescence

like an involucre; oldest flower with the pedicel curving downwards, longer than the calyx: sepals nerved, pilose, white-margined, lanceolate, 6^{mm} long, apex obtuse or emarginate: petals white, as long as the sepals: capsule a little longer than the calyx, the valves revolute after opening.

Type range: "in Scaniae aut Europae australioris pratis."

58. LYCHNIS APETALA L. Sp. Pl. 437. 1753.—Stems 12–15^{cm} high, glandular-villous: radical leaves obovate to lanceolate, 15^{mm} long; cauline leaves two pairs: flowers pendulous at first, later erect: calyx inflated, glandular, having ten purplish nerves: petals exserted about 2^{mm}.

This is perhaps var. *elatior* Regel. Bull. Soc. Nat. Mosc. **34**: 573, of which the type locality is given as Kodiak island and northward in Alaska to Kotzebue sound (ex Gray's *Syn. Fl. N. Am.* **1**: 226).

59. SILENE ACAULIS L. Sp. Pl. ed. 2. 603. 1762.—Cespitose, often covering broad areas: leaves linear, one-nerved, glabrous, ciliate on the margins, 5^{mm} long: flowers on peduncles about their own length: calyx purplish with deltoid divisions, ciliate on the margins: petals rose-color, with spreading blades and exserted claws: stamens exserted.

Type range: "in Alpibus Lapponicis, Austriacis, Helveticis, Pyrenaecis." This is commonly regarded as a flowering moss as it covers the ground like moss.

60. STELLARIA LONGIPES Goldie, Edinb. Phil. Jour. **6**: 327. 1822.—Stems erect, with erect branches, glaucous or often shining, glabrous: leaves lanceolate-acuminate to ovate, one-nerved, about 5–10^{mm} long, with longer internodes: flowers cymose, the lateral ones with a pair of membranous bracts below the middle; peduncles long, almost 3^{cm}: sepals ovate, keeled, 2^{mm} long, with the margins white-membranous, ciliate: petals white, surpassing the sepals: capsule glossy, surpassing the calyx by about 1^{mm}, brownish (perhaps not ripe).

Type locality: "woods near Lake Ontario."

RANUNCULACEAE.

61. ACONITUM DELPHINIFOLIUM DC. Syst. **1**: 380; Reichenb. Monogr. Gen. Aconiti 79. *pl.* 9.—Stems erect, 4–5^{dm} high,

slender with few leaves, simple or with few erect branches, retrorsely pubescent: leaves about 5^{cm} across, 3–5-parted or divided with the divisions laciniately cleft into linear acute lobes, 2–3^{mm} broad, glabrous, paler on the lower surface; petioles long and slender, glabrous, slightly dilated only at the base: flowers few on long pedicels, lowest pedicel 5^{cm} long from a leaf-like bract; the upper bracts with one or two divisions; bracts and pedicels pubescent: hood not much surpassing the other sepals; lower sepals half as broad as the lateral and of the same length: follicles erect, spreading at apex, marked with dark reticulation, sparsely pubescent.

Type locality of Reichenbach: "in Kamtschatka" (ex Ledeb. *Fl. Ross.* 1:70). Depauperate one-flowered specimens are not uncommon. Common everywhere, especially under the willow trees.

62. ANEMONE NARCISSIFLORA **uniflora** Eastwood, n. var.—Stems 1–2^{dm} high, glabrous or villous: radical leaves pedately 3-divided with the cuneate-flabelliform divisions cleft into 5–7 unequal, oblong or linear, acute lobes; petioles dilated at base, imbricated, two- to three-nerved, 4–6^{cm} long; blade 2-4^{cm} across, generally villous-ciliate on the margin, paler on the lower side than the upper; involucral leaves similar to the divisions, sessile, more or less densely villous at base and on the lower surface, 1.5^{cm} long: flowers solitary in the involucre on a peduncle elongating from 3–5^{cm}: sepals rhombic-obovate, 1.5^{cm} long, almost 3^{cm} broad, though somewhat unequal: stamens numerous: akenes in a globular head, glabrous, with the style much recurved.

This differs so much from the usual form in general appearance as well as in the number of flowers that it seems deserving of varietal rank.

63. ANEMONE PARVIFLORA Michx. Fl. 1:320. 1803.—Stems erect from a creeping rootstock, woolly pubescent, 5^{cm} to 2.5^{dm} high: leaves palmately 3-divided, with the divisions broadly cuneate, three-lobed with uneven rounded lobes, bright green on the upper surface, paler on the lower, the marginal teeth callous-tipped, reniform in general outline, 1–3^{cm} across; petioles long and slender, sheathing at base, striate; involucral leaves

more deeply lobed, sessile or on very short broad petioles: flowers terminal, solitary, white or tinged with blue, almost 3^{cm} in diameter: sepals obovate, about 3^{cm} broad: akenes in an oval head, densely white-woolly, with the capillary styles generally deciduous.

Type locality: "ad amnes in sinum Hudsonis defluentes."

64. ANEMONE RICHARDSONI Hook. Fl. Bor.-Am. 1:6. *pl. 4.* 1840.—Stems erect, from slender creeping rootstocks, $1–1.5^{dm}$ high: radical leaves three- to five-lobed, the lobes broadly cuneate, irregularly dentate, reniform in outline; petioles $2–4^{cm}$ long, villous, sheathing only at the very base, veined; cauline leaves three, involucrate, sessile, similar to the radical leaves but not so broad: peduncles lengthening from $2–12^{cm}$: sepals yellow, ovate, veiny, pilose on the lower side, obtuse: akenes in a short head, pointed with the long slender uncinate styles which are about 5^{mm} long.

Type range: "Eastern primitive district, shores of Hudson's bay: barren ground, Rocky mountains, from lat. 55° to 68°, in wet mossy ground. Unalashka and throughout all Siberia."

65. COPTIS TRIFOLIA Salisb. Trans. Linn. Soc. **8**: 305.—*Helleborus trifolius* L. Sp. Pl. 558. 1753.—Rootstock yellow, slender, filiform: leaves all radical, trifoliate; divisions obovate-cuneate, with crenate-dentate margins and mucronate teeth, evergreen, glossy, glabrous: petioles long, slender, almost equaling the scape: scape 1-flowered (in the only specimen): sepals oval, white, tinged with purple, 6^{mm} long: petals orange, clavate, 2^{mm} long: stamens surpassing the petals: fruit wanting.

Type range: "in Canada, Siberia."

66. **Delphinium Blaisdellii** Eastwood, n. sp.—Root unknown: caudex woody, branching: lowest leaves less dissected than the upper ones, with four or five 3–5-parted divisions, obovate in outline, laciniately cleft into linear lobes which are entire or with a few teeth near the apex; divisions of the upper leaves with 4–7 linear-acuminate divisions diverging pinnately from the broad rhachis and diminishing towards the apex; petioles dilated at base (1^{mm} broad), somewhat canescent with silky pubescence, longer

than or equaling the blades: lowest flowers axillary on downy peduncles, which are erect but recurve at apex, about 2^{mm} long; upper ones from slender bracts, forming a rather dense raceme: divisions of the calyx about as long as the spur, elliptical, silky villous exteriorly, dark blue with black spot near the apex; spur slender, 2.5^{cm} long, tapering to an obtuse apex less than 1^{mm} wide, straight or curved, slightly erect or horizontal: upper petals white, veined with blue; lower bearded with yellow hairs: immature capsules densely clothed with white silky wool.

This may have been identified with *D. Menziesii* Lindl. Bot. Reg. *pl. 1192*, as this seems to have been the only species reported from the arctic region. It is very different from the figure in the *Botanical Register*, and quite unlike any specimen identified as that species in the herbarium of the California Academy of Sciences. Without the root and ripe or fully grown fruit, it is not wise to name species of Delphinium, but in a list like the present one it is better to name it, if it is described, than to leave it described but unnamed.

67. RANUNCULUS NIVALIS L., Sp. Pl. 553. 1753; Fl. Lapp. *pl. 3. fig. 2.*—Roots fibrous: caudex often branched, sheathed with membranous bases of old leaves: radical leaves cuneate, 3–5-lobed, on long petioles; cauline sessile, one or two with deeper and more spreading divisions: flowers yellow, 2^{cm} across: calyx of orbicular sepals clothed with brown hairs: petals almost twice as long, orbicular to obovate, obtuse, veiny: head of akenes oblong, on an elongated peduncle; akenes orbicular, somewhat turgid, tipped by a straight or curved style, glabrous or slightly villous.

Type range: "in Alpibus Laponiae, Helvetiae."

68. RANUNCULUS PYGMAEUS Wahl. Fl. Lapp. 157. *pl. 3. fig. 3.* 1812.—Stems woolly-pubescent, low and slender (3–8^{cm} high), from an ascending rootstock: radical leaves pedately 3–5-cleft, with unequal rounded lobes: petioles unequal, much dilated at base, 3-veined, sparsely ciliate: cauline leaf about the middle of the 1-flowered stem, palmately 3-cleft: flowers yellow, 8–9^{mm} across: sepals villous, about as long as the orbicular petals: akenes in an oblong head, tipped with a curved style.

Type locality: "alp. Lapponiae" (ex Ledeb. *Fl. Ross.* 1: 36). On the edge of glaciers, Swan gulch.

69. **Ranunculus verticillatus** Eastwood, n. sp.—Stems slender, weak, reclining or ascending, glabrous near the base, sparsely and finely pilose above, simple or dichotomously branched: radical leaves none; cauline leaves divided palmately to the base, the linear entire divisions appearing like 4–6-whorled leaves, varying but little in length, in different leaves from 5–20^{mm} long to 3^{mm} wide, minutely appressed-ciliate on the margins, and with longer cilia at the base, dotted on the upper surface (under a lens) with the minute pustules of the pubescence: earliest peduncle (if more than one) naked, 3–10^{cm} long; later ones, with one or rarely two leaves, having fewer divisions than those of the main stem: flowers solitary, bright yellow: sepals woolly-pubescent, boat-shaped, 6^{mm} long, 6^{mm} broad (if spread out): petals obovate, narrowed to a short claw, 7^{mm} long, 5^{mm} broad, the scale at the base shaped like a wishbone, each part 1^{mm} long: akenes pubescent, orbicular, turgid, with tortuous styles 1^{mm} long, forming a globose head.

FIG. 3.—RANUNCULUS VERTICILLATUS. *a*, plant four-fifths natural size; *b*, petal × 4; *c*, pistil × 4; *d*, sepal × 4.

This interesting species seems to come nearest to *R. affinis* R. Br., but is quite dissimilar to any of the forms of that heteromorphic species.

70. THALICTRUM ALPINUM L. Spec. Plant. 545. 1753.—Stems

scapose from fibrous roots, slender, 1–1.5^{dm} high: leaves all radical, trifoliate, with the leaflets pinnately divided, the segments cuneate, 2–3-toothed at apex: flowers perfect, racemose, on capillary pedicels, from small bracts, erect or pendent: anthers narrowly oblong, mucronate, on capillary filaments: akenes few, pointed.

Type range: "in Alpibus Lapponiae, Arvoniae."

PAPAVERACEAE.

71. PAPAVER NUDICAULE L. Sp. Pl. 507. 1753.—Caudex branching underground: leaves all radical, ovate in outline, pinnately divided, with the three upper divisions confluent, the other two or four entire, or once or thrice lobed, the lobes spatulate, sparingly hispid, with revolute margins, obtuse or aristate at apex; petioles about as long as the blades, together 2–4^{cm}, dilated at base and imbricated, hispid-ciliate: scapes slender, 1–2^{dm} high, more or less hirsute with spreading brown-black hairs: bud elliptical, hirsute with brown-black hairs: flowers bright yellow turning greenish in drying, 2.5–4.5^{cm} in diameter; two petals broader than long, the other two almost orbicular, cuneate at base: capsule brown, 4-ribbed, turbinate-oblong, 10–15^{mm} long, 2–3^{mm} wide at apex, hispid with pustulate hairs: stigma with four glandular-puberulent rays: seeds 1–2^{mm} long, chestnut-brown, glossy, with the outer coat wrinkled and marked with quadrangular venation, having a dark brown spot at one end.

Type locality: "in Siberia." This is a variable species. These specimens agree with none of the described varieties in all particulars.

This species is named *P. radicatum* Rottb. in U. S. Geol. Surv. Reconnaissances in the Cape Nome and Norton bay regions, Alaska, in 1900, p. 170. In *Index Kewensis P. radicatum* is a synonym of *P. nudicaule* L.

FUMARIACEAE.

72. CORYDALIS PAUCIFLORA Pers. Syn. **2**:69. 1805; Ledeb. Ic. Fl. Alt. *pl. 450.*—*Fumaria pauciflora* Steph. in Willd. Sp. Pl. **3**:861. 1797–1830.—Stem 1.5^{cm} high (the only specimen is in fruit and is without the root): leaves on long petioles, of three palmate divisions, these again 3–4-parted with oblong or obovate

mucronate divisions, glabrous, 3^{cm} in diameter, orbicular in outline: bracts ovate, somewhat keeled: capsules pendent on erect or spreading slender pedicels, 15^{mm} long, equaling the oblong-lanceolate capsules; these tipped with a persistent style 1^{mm} long, and a tufted stigma: seeds orbicular, black, in two rows.

Type locality: "in montibus Altaicis Sibiriae." According to the description and the figure in Ledebour the corolla is purple and long-spurred.

CRUCIFERAE.

73. CARDAMINE BELLIDIFOLIA L. Sp. Pl. 654. 1753.—Caudex branched from a fibrous coated rootstock (the fibers the dry petioles of former leaves): glabrous throughout: stems 4–9^{cm} high, slender: radical and lower cauline leaves on long slender petioles, 1–2^{cm} long with ovate or orbicular blades 4–6^{mm} wide; upper stem leaves sessile or occasionally with short petioles: flowers white, in corymbs lengthening to racemes, on pedicels 3^{mm} long, which become somewhat longer in fruit: sepals generally purplish, with white margins, oblong, about 2^{mm} long: petals white, cuneate, 4^{mm} long, 2^{mm} wide, tapering to a claw: style short and stout: pods too young to describe.

Type range: "in Alpibus Lapponiae, Helvetiae, Brittaniae."

74. **Cardamine Blaisdellii** Eastwood, n. sp.—Rootstock horizontal, slender: glabrous throughout, with erect stems 1–2^{dm} high; radical and lower cauline leaves of three to five 2–3-lobed petiolulate leaflets 5–8^{mm} broad, the lobes with callous apex; petioles equaling or longer than the blades, flattened; upper cauline leaves with 3–5 oblanceolate entire petiolulate divisions, 5–8^{mm} long, callous-tipped: inflorescence corymbose, lengthening to a raceme 9^{cm} long; pedicels flattened, becoming 2^{cm} long: sepals broadly oblong, yellow, margined with white, obscurely 3-nerved, 3.5^{mm} long, 2^{mm} wide, slightly bullate: petals white, broadly spatulate, tapering gradually from the rounded upper part to the base of the claw: immature pods very slender, 2^{cm} long, narrowed at each end, but expanding under the clavate stigma.

This seems to be intermediate between *C. pratensis* L. and *C. purpurea* Ch. & Schl., but is distinctly different from either. The cauline leaves are sometimes simple and solitary.

75. CARDAMINE PRATENSIS L. Sp. Pl. 656. 1753.—Rootstock obliquely ascending: stems glabrous, 1.5–2 dm high: radical leaves of 5–7 orbicular petiolulate leaflets, each 5–10 mm broad, the upper one largest; petioles long and slender, about 2–3 cm; cauline leaves of 11–13 linear-oblanceolate divisions 2–5 mm long, 0.5–1 mm broad, the whole leaf 4 cm long: flowers at first corymbose, lengthening to a raceme; pedicels 7–10 mm long: sepals yellow, white-margined, 4 mm long, two slightly saccate at base: petals white turning rose-color, obovate, obtuse or obcordate, unguiculate, 10 mm long, 4–5 mm broad: pods erect, slender, purplish and green, 3 cm long, less than 1 mm wide; style short.

Type range: "in Europae pascuis aquosis."

76. CARDAMINE PURPUREA Ch. & Schl. Linnaea 1:20. 1826.—Rootstocks slender, creeping: stems hispid, erect, about 7 cm high: leaves few, cauline one or two; radical and lower cauline leaves similar, of three orbicular leaflets, the upper one petiolulate, with three callous teeth or lobes, broadly ovate or orbicular, 8 mm wide, glabrous, with margins ciliate; the lateral leaflets smaller, sessile, 3 mm wide; petioles 1–3 cm long: inflorescence usually subtended by an entire or lobed leaf, corymbose: sepals yellowish, keeled, half as long as the petals, glabrous, the two outer spurred at base: petals purplish, oblanceolate, tapering to a rather broad claw, together 6 mm long: pods glabrous, 17 mm long, on pedicels 5 mm long, beaked with a stout style 1–2 mm long.

Type locality: "in insula St. Laurentii."

77. COCHLEARIA OFFICINALIS L. Sp. Pl. ed. 2, 903. 1762.—Stems low, several from a tap root, branching above with one or two divaricate branches: radical leaves broadly ovate to orbicular, entire or obscurely lobed, truncate, cuneate or cordate at base, 5–10 mm broad, on petioles 1.5–3.5 cm long; upper cauline leaves sessile with auricled base, ovate-oblong, entire or with a few blunt teeth: flowers crowded at the ends of the branches: sepals yellowish, white-margined, spoon-shaped, about half as long as the petals: petals elliptical obovate, white, 6 mm long with the claw distinct: stamens with subulate filaments shorter

than the ovary and orbicular anthers: ovary orbicular, tipped with a short style and capitate stigma.

Type range: "in Europae borealis littoribus marinis."

78. DRABA ALPINA L. Sp. Pl. 642. 1753.—Cespitose with branched caudex clothed with the bases of old leaves: leaves all radical, oblanceolate, acute, with prominent midnerve, ciliate on the margin with simple or branched hairs, about 1^{cm} long and 2^{mm} wide: scapes 2.5^{cm} high, pubescent with spreading hairs, slender: flowers two or three in a capitate cluster: sepals oblong-elliptical, greenish, yellow-margined, 2^{mm} long, slightly hairy near the top: petals yellow, twice as long, obcordate, unguiculate: pods not present as the specimens are too young.

Type range: "in Alpibus Europae."

79. DRABA HIRTA L. Syst. ed. 10. 1127. 1758.—Stems several from a branched caudex, canescently stellate-pubescent throughout, about 8^{cm} high, one or two-leaved near the base: radical leaves oblanceolate, about 15^{mm} long, sessile, imbricated at base, callous-tipped, rarely with one or two teeth; cauline leaves broadly ovate, clasping: flowers white, corymbose, on pedicels 2–4^{mm} long: sepals green, white-margined, oblong, acute, 2^{mm} long: petals white, oblong, unguiculate, 5^{mm} long: pods not present.

80. DRABA HIRTA **tenella** Eastwood, n. var.—Stems several from a branched caudex, stellate-pubescent, one-leaved, slender, 6–15^{cm} high: radical leaves oblanceolate, tapering to broad margined petioles, 2–5^{mm} wide, about 15^{mm} long, acute, ciliate with forked hairs; cauline leaf sessile often with one or two blunt teeth: flowers corymbose, pedicellate: sepals oblong-elliptical, white-margined, 2^{mm} long: petals as long again, emarginate at apex, oblanceolate-spatulate, tapering to a claw of half the length: pods on pedicels of about equal length, 7^{mm}, linear-oblong and tapering at each end or lanceolate, glabrous, tipped with a short style and slightly emarginate stigma.

In fruit the raceme often becomes elongated.

81. PARRYA MACROCARPA R. Br. in Parry's 1st Voy. Suppl. to App. 270. 1823.—Caudex branched, covered with white

bleached persistent dilated leaf bases: leaves all radical, narrowly oblong to lanceolate, glabrous, deeply or but slightly dentate, with callous-tipped teeth, tapering to a petiole, together 1.5–5^{cm} long: scape glabrous: flowers corymbose; peduncles and pedicels glandular-hispid, the latter 3–4^{cm} long: sepals purplish, linear-oblong, two spurred at base, the other two hooded at apex: petals white or purplish, obcordate at apex, obovate, tapering to a long claw, together 12^{mm} long: pods 1–5-seeded, veiny, rough-hispid, constricted between the seeds: style 2^{mm} long; stigma 2-cleft: seeds winged, orbicular, 3^{mm} broad.

Type locality: "Melville island."

CRASSULACEAE.

82. SEDUM RHODIOLA DC. Fl. Fr. ed. 3, **4**: 386. *pl. 143.*—*Rhodiola rosea* L. Sp. Pl. 1035. 1753; *Sedum roseum* Scop. Fl. Carn. ed. 2. **1**: 326. 1772.—Stems erect from a fleshy creeping rootstock, erect, 1–2^{dm} high, leafy, glabrous: leaves fleshy, oblong, serrate: flowers capitate-glomerate, deep reddish-purple, terminating the stem.

Tpye range: "in Alpibus Lapponiae, Austriae, Helvetiae, Brittaniae."

(*To be continued.*)

BRIEFER ARTICLES.

TWO INSTRUCTIVE SEEDLINGS.

(WITH EIGHT FIGURES)

LUBBOCK,[1] in his work on seedlings, mentions not a few examples of lobed cotyledons, and of the appearance on such structures of trichomes of various kinds. The first of these peculiarities he attributes to the need of compact folding in the seed, which may often be of a shape to necessitate such lobing; for the second he gives no reason. A couple of seedlings which I have lately examined show facts which appear to bear directly upon the question both of lobation and of pubescence in cotyledons; these facts I present, together with a slight discussion of what they suggest.

The cotyledon of *Erodium cicutarium* L'Her. (*fig. 1*) has a distinct petiole and an oblique base, the right side, as viewed from above, being constantly higher than the lower. Into the lamina two indentations project, the right one always remaining the more distal. This is the normal condition for the species. But lobing is often carried further than this in the cotyledon, as seen in *fig. 2*, where the form represented is by no means extreme in this respect. Even when extra lobing occurs, the two indentations noted in the normal cotyledon still persist.

The reason for this lobing is perhaps a bit doubtful. Lubbock accounts very well for the oblique character, but seems hardly to make clear the cause of further changes in form, though not only for the species, but also for several others, he mentions them and takes notice of their somewhat inconstant character. To explain this, the slight variation in the shape of the seeds could hardly be regarded as sufficient. There seems, however, to be another view permissible, which may partly, at least, clear up the difficulty, if due care is taken not to press it too far. A glance at the adult plant shows leaves very finely divided, of increasing complexity as one passes from the nepionic, or early seedling leaves, where it is indeed comparatively well-developed,

[1] A contribution to our knowledge of seedlings. 2 vols. 1892.

up to the larger ones of the full-grown individual. Keeping in mind the fact that with the gradual change and increase in complexity of the adult in phylogeny, the representation of past adult stages is pushed further and further back in the ontogeny of the plant, one does not find it at all difficult to carry the idea a single step onward, and to consider the changes in cotyledonar form as influenced by this acceleration in development. Lubbock states that the lobing is perhaps deeper in *E. cicutarium* than in the other species, which are also less lobed or pinnatifid in the adult. As regards the extra lobing in cotyledons of *E. cicutarium*, therefore, I am inclined to adopt the view that acceleration in development supplies the most plausible reason, and to recognize the possibility of accounting thereby for the two constant lobes as well.

That lobation may take place for the sake of compact folding seems, however, fully to be demonstrated by the other seedling with which I am to deal. The genus Amsinckia has deeply parted cotyledons (*fig.* 7), but the following leaves throughout the life of the plant are simple, lanceolate, and entire. Hence it is equally possible that in *E. cicutarium* such lobes as are of a constant nature may likewise be due to this cause, as argued by Lubbock. Researches upon the seedlings of simpler leaved species of Erodium would give interesting evidence upon this point.

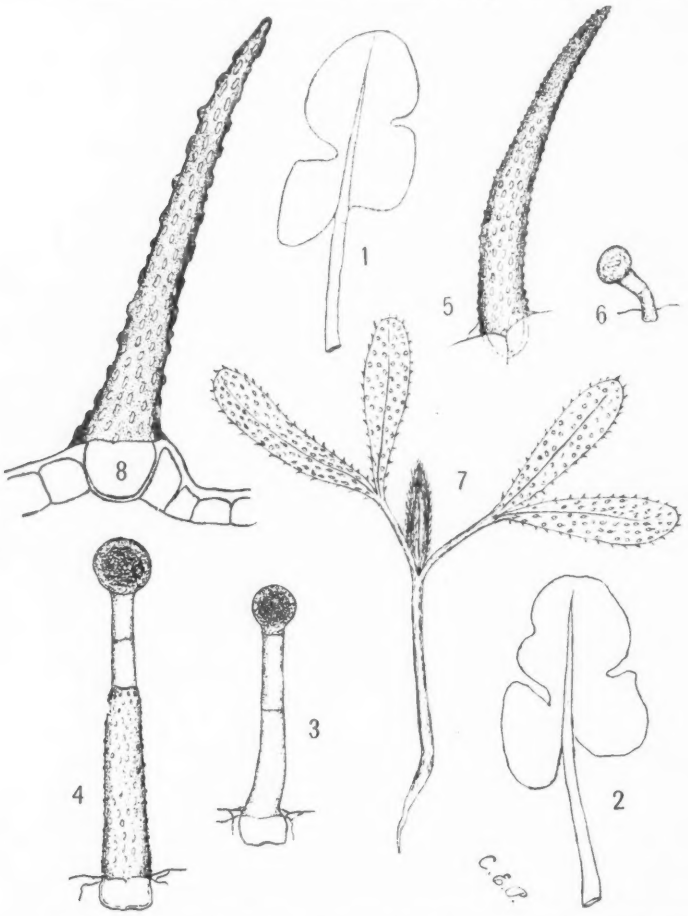
Far more instructive seems the phylogeny of the trichomes in these two seedlings, both of which possess hairy cotyledons. The fact that both Geraniaceae and Borageineae are characterized so generally by hairy plants is in itself significant as pointing out the early appearance of trichome in their phylogeny. The same is also true of the Hydrophyllaceae, where hairy cotyledons are likewise of frequent occurrence. Accepting the views expounded by many writers, among whom may be mentioned Schäffer[2] and Jackson[3] as dealing with the botanical side of the question, viz., that the early leaves of seedlings represent closely the leaves of past adult conditions, we are justified in saying that the trichomes found thereon likewise represent those found on past adults. We therefore gain, in the ontogeny of the plant, a fairly good series illustrating the later phylogeny of the trichome. As

[2] Ueber die Verwendbarkeit des Laubblattes der heute lebenden Pflanzen zu phyletische Untersuchungen. Abhandl. naturwiss. Ver. Hamburg **13**: 36 pp.

[3] Localized stages in the development of plants and animals. Mem. Boston Soc. Nat. Hist. **5**: 89–153. *10 pls.* 1899.

with the lobing, it is easy to suppose that the earlier stages may be thrown back upon the cotyledon.

The examination of *Amsinckia tessellata* Gray, the species used,



FIGS. 1–6, *Erodium cicutarium:* *1*, normal cotyledon; *2*, cotyledon with extra lobes; *3*, glandular hair on cotyledon; *4*, intermediate stage from early nepionic leaf; *5*, trichome of adult leaf; *6*, retrograde gland from adult leaf.— FIGS. 7, 8, *Amsinckia tessellata:* *7*, seedling; *8*, trichome of adult leaf.

brings to light little of importance. The trichome of the adult leaf (*fig. 8*) is large, heavy, and rough warty; that of the cotyledon is already somewhat roughened but is much smaller and less highly tuberculate. *Erodium cicutarium*, on the other hand, shows a definite series of structures, all of which are apparently phylogenetically descended from one of the number.

The hair found on the cotyledon of *E. cicutarium* (*fig. 3*) is glandular, consisting of a round, single celled head, and of two or three stalk cells, the walls of which, even under high power, appear perfectly smooth. No other modified epidermal structures occur in the cotyledons. The glands upon the petiole are similar, often longer stalked.

Upon the lamina of an early leaf may be found structures of three kinds. The first is the gland already described; this, however, is far less common here than on the cotyledons. A second is a modification of the first by the heavy cutinization and roughening of the basal cell (*fig. 4*). This type is usually somewhat larger than the earlier gland. The third structure is a simple, rough warty, pointed trichome (*fig. 5*). On a leaf of this stage the last two mentioned occur in about equal proportions. On the petiole the long stalked gland of the cotyledon seems to maintain its position, but even here the walls of its basal cell begin to show a thickening and more or less of the tubercular character.

In the mature leaf, the simple, unicellular, thickened, and tuberculated point constitutes an almost continuous covering over the surface. The individual trichomes are greatly enlarged and elongated. In addition to this form there is present a smaller number of minute glands (*fig. 6*), short stalked and with heads far inferior in size to those of the cotyledonar glands, these still maintaining the primitive thin walled character. The other forms are almost completely absent.

This series seems to show a variation of the primitive glandular structure along two lines during the phylogeny of the plant. The first of these lines demonstrates the peculiar development, out of a glandular structure, of a simple, rough warty point; the second, the mere degeneration of the stalked gland. The gland of the nepionic leaf (*fig. 4*) seems undoubtedly to be a form intermediate between the primitive gland (*fig. 3*) and the rough warty point of the adult (*fig. 5*), the latter being evolved from the former by the modification of the basal cell and the gradual cessation in development of the upper parts.

In one case I found a poorly developed gland on the tip of a pointed trichome in an adult leaf, but this, though a very instructive intermediate stage, is certainly an exceptional occurrence. As a rule these points are well developed early in the ontogeny of the leaf, and it seems very doubtful whether each one passes through a primitive glandular stage in its development.

As regards the small glands still present, it may be pretty safely concluded that they are a somewhat retrograde condition of the primitive glands. One of such retrograde glands is represented in *fig. 6*, of equal relative size with the other figures of trichomes. These are of much more frequent occurrence on the petiole, where also the stalked glands persisted longest unmodified, than on the lamina. It is also worthy of note that they reach their highest development at an earlier period in the unfolding of the leaf than do the rough warty points, another fact which gives evidence of their direct descent from a primitive structure.—CARLETON E. PRESTON, *Harvard University*

SOME LITTLE KNOWN PLANTS FROM FLORIDA AND GEORGIA.

THE collections made by Mr. A. H. Curtiss during the past summer contain a number of species, which apparently are unrecorded from Florida and Georgia. Among the more interesting of these are the following:

NAJAS CONFERTA A. Br. in Sitzungsb. Ges. Naturf. Fr. Berlin 17. 1868. This species, formerly known only from Brazil and the West Indies, was found abundantly in tidal creeks near Milton at the head of Pensacola bay, Florida, August 3, 1901 (no. 6858.)

FIMBRISTYLIS SCHOENOIDES Vahl. Enum. 2 : 286. An Indian and Australian plant collected by Mr. Curtiss in Walton co., Florida, in 1886, and again on September 23, 1901, by roadsides and in miry spots near Milligan, Santa Rosa co., Florida (no. 6912).

MAYACA FLUVIATILIS Aublet, Pl. Guian. 1 : 42. *pl. 15* (*M. Aubletii* Schott & Endl.) A species described from South America, but found fruiting by Mr. Curtiss in creeks at Milligan, Florida, September 24 (no. 6913). Readily distinguished from *M. Aubletii* Michx. (*M. Michauxii* Schott & Endl.) by its very short thick peduncles.

POEPALANTHUS PILULIFER Koenicke in Mart. Fl. Bras. 3^1 : 426. *pl. 55. fig. 1.* Plants found by Mr. Curtiss in moist cultivated ground

bordering Lake Louisa, Seville, Volusia co., Florida, September 3 (no. 6894), are identified with Koernicke's description and plate.

ATRIPLEX LAMPA Gillies ex Moq. in DC. Prodr. **13**[2] : 110. A South American species introduced upon ballast grounds near Pensacola (no. 6865).

GALENIA SECUNDA Sond. in Harv. & Sond. Fl. Cap. **2** : 474. A South African plant introduced and now forming broad mats in waste ground about Pensacola (no. 6869).

ILEX DECIDUA Walt. var. **Curtissii**.—Leaves as in the species, but when mature only 1 or 2 [cm] long: berries smaller than in the species, 4 or 5 [mm] in diameter.—Dryish land sloping to the Suwannee river-bottom, Branford, Florida, October 24, 1900 (no. 6736). According to Mr. Curtiss's notes the trees in the neighboring swamp had similarly reduced leaves. Again collected by Mr. Curtiss on Peace river, near Nocatee, De Soto co., Florida, April 13, 1901.

SAPIUM BIGLANDULOSUM Muell. Arg. var. LANCEOLATUM Muell. Arg. Linnaea **32** : 118. A native of Brazil, Argentine Republic, and French Guyana, introduced in waste places at Pensacola (no. 6859).

LECHEA LEGGETTII Britton & Hollick, Torr. Cl. Prelim. Cat. N. Y. 6. In dry pine barrens near St. Marks, Wakulla co., Florida, July 25, 1901 (no. 6847). Rare or unrecorded south of Virginia.

Lythrum Curtissii.—Stems slender, glabrous, prominently 4-angled, ascending and loosely branched above, 6 or 7 [dm] high: leaves glabrous, thin, lanceolate to elliptic-oblong, short-petioled or subsessile; the the primary ones 2 to 5.5 [cm] long; those of the elongated slender branches mostly 1 to 1.5 [cm] long: flowers mostly solitary in the axils: calyx narrowly cylindric, slightly constricted at the throat, strongly ribbed, glabrous, 3 [mm], becoming 5 [mm] long, the deltoid-subulate lobes somewhat exceeding the bristle-like appendages: petals 6, the oblong-oval limb 2 [mm] long, pale purple with a dark stripe: stamens long-exserted.—In a miry swamp, Leary's, Georgia, August 19, 1901 (no. 6876), and formerly collected in Florida at Aspalaga, October 1897 (*Chapman*, no. 6170 of Biltmore Exsiccatae). Related to *L. lanceolatum* Ell., but of more slender flexuous habit, and with thinner leaves and fewer smaller flowers.

Sabbatia foliosa.—Perennial from elongated slender rootstalks, freely stoloniferous, the simple or loosely branching somewhat flexuous stems 2 to 5 [dm] high: leaves very numerous, 8 to 12 pairs below the lowest flowering branches, lanceolate to oblong-lanceolate, thin and

wide-spreading, essentially uniform to the top of the plant, 2.5 to 6 cm long, 0.5 to 1.2 cm broad, mostly equaling or exceeding the internodes: flowers solitary and terminal or at the tips of the loosely ascending branches: calyx with 7 to 10 lanceolate foliaceous lobes 1.2 to 2 cm long: corolla rose-colored, with 8 to 10 oblanceolate remote lobes 1.3 to 2.5 cm long and 5 to 7 mm broad.— Swampy thickets on North Edista river, Orangeburg district, South Carolina, August 9, 1884 (*John Donnell Smith*); muddy banks of Blackwater river, near Milton, Florida, July 8, 1897 (*A. H. Curtiss*, no. 5928). Formerly called *S. chloroides* Pursh, from which it differs in its elongated rootstalk and more stoloniferous habit, its thin uniform leaves equaling the internodes, its foliaceous calyx lobes and narrower corolla lobes. From the habitally similar annual *S. calycosa* it differs in being perennial, in its larger usually 10-lobed corolla and narrower more numerous calyx lobes.

Scutellaria glabriuscula.— Stems two to several from a somewhat woody short caudex, slender and arcuate, simple or branching, 3 to 7 dm high, minutely puberulent: leaves narrowly oblanceolate, mostly 2 or 3 cm long, short-acuminate, narrowed to slender petioles 0.5 to 1.5 cm long, all but the lowermost entire, glabrous, viscid and glandular-pruinose: inflorescence racemose or racemose-paniculate, with reduced linear or linear-lanceolate floral-leaves: pedicels 2 to 4 mm long, puberulent and occasionally with scattered stipitate glands: calyx glandular-pruinose, minutely puberulent on the angles and margins: corolla 2.5 cm long, glabrous, the slender tube and obliquely flaring throat whitish, the lips purplish.— Dry sandy pine-woods, Walton co., Florida, September 15, 1886, and dry scrub lands near De Funiak springs, Walton co., September 21, 1901 (*A. H. Curtiss*, nos. 3, 6907); pine-barrens, Westville, Holmes co., Sept. 18, 1901 (*A. H. Curtiss*). Related to *S. integrifolia* L., but differing from that in its more slender less pubescent stems, narrower slender-petioled glabrous leaves and subglabrous calyx; and from *S. integrifolia* and its immediate allies in its glabrous corolla. *S. integrifolia*, a plant of moist soils, flowers in spring and early summer, while *S. glabriuscula* grows only in dry soil and flowers in autumn.

PERILLA OCYMOIDES L. Gen. ed 6. 578. An Indian species reported by Mr. Curtiss as "abundant in streets of various towns in northwestern Florida and southwestern Georgia. In low woods near Bainbridge, Georgia." Collected August 14, 1901, at Bluff springs, Florida (no. 6874).

PLUCHEA QUITOC DC. Prodr. 5 : 450. Native of Brazil and Chili. Collected by Mr. Curtiss on ballast at Pensacola in 1886, and on August 12, 1901, found established in moist ground near Pensacola (no. 6873).

Cacalia sulcata.—Stem 1 to 1.5 m high, deeply furrowed : leaves from ovate to ovate-oblong, glabrous, green on both sides, faintly nerved ; the lowest long-petioled, blunt and undulate-dentate ; the upper sessile, acuminate, deeply and coarsely acuminate-serrate : corymb broad and loosely branched : the narrowly campanulate involucre of 5 oblong bluntish bracts 8 or 10 mm long ; the pedicels minutely calyculate-bracted : corolla deeply cleft.—Clearings in edge of swamp near Smithville, Georgia, August 26, 1901 (*A. H. Curtiss*, no. 6884 A). Related to *C. ovata* Ell., but differing in its deeply furrowed lower green stem ; green, not glaucous, more cut leaves ; and later flowering season—the taller glaucous *C. ovata* with unfurrowed stem flowering some days earlier in the same region.—M. L. FERNALD, *Gray Herbarium*.

THE MORPHOLOGY OF THE PINE CONE.[4]

(WITH PLATE VIII)

SO MUCH has been said in regard to the morphology of the cone of the pine and its near allies that it would seem impossible as well as unnecessary to suggest anything further. However, the recent excellent summary in Coulter and Chamberlain's "Morphology of the Spermatophytes" of the many theories hitherto advanced to clear up the matter, and the conclusions reached by the authors named, show that it is by no means settled, and perhaps warrant me in presenting an interpretation which I have used in lectures before my own classes for half a dozen years or more.

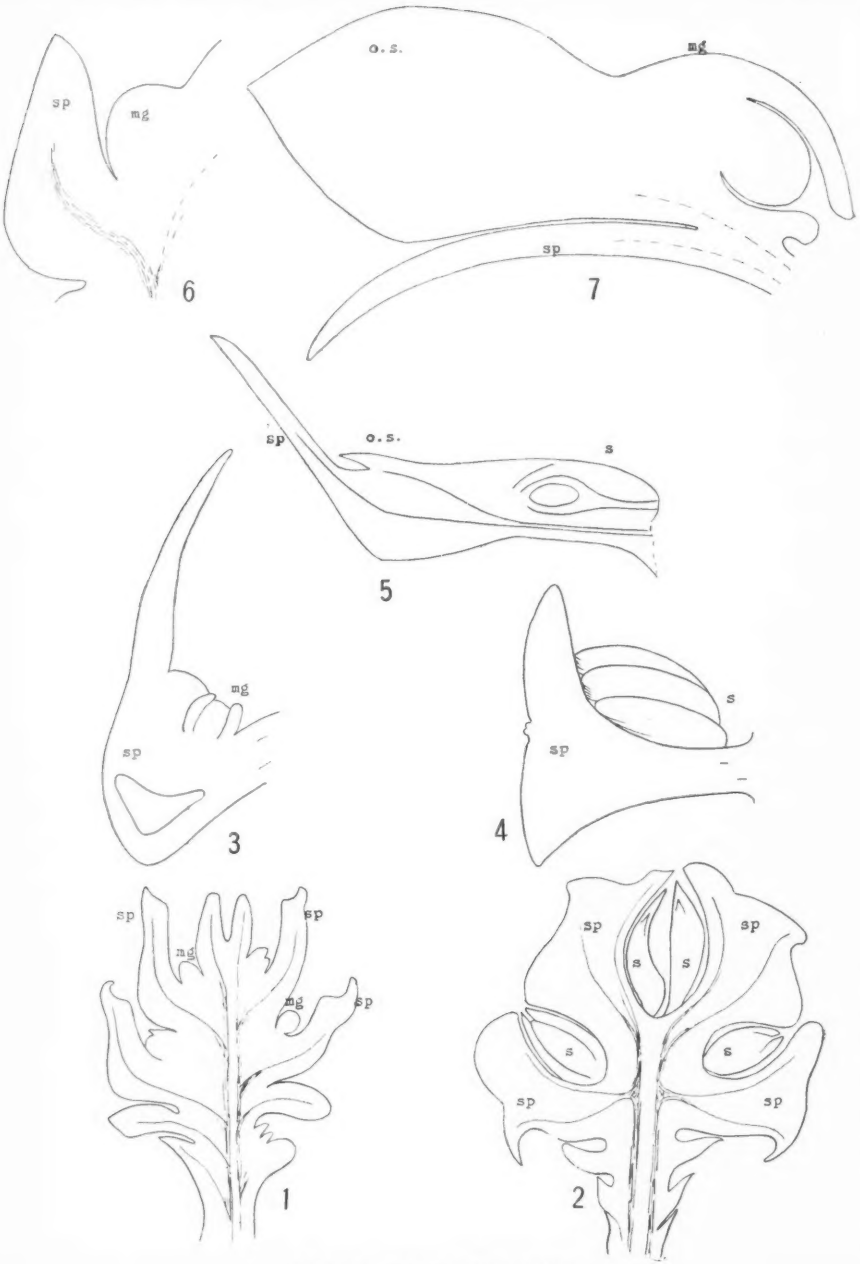
The point at issue is, in short, the morphological nature of the so-called "ovuliferous scale," a structure present in the cones of the Abietineae, but rudimentary or wholly wanting in the other tribes of the Pinaceae. In a pine cone the axis bears bracts which are the homologues of the stamens in the staminate cones, and in addition to these bracts there are thick, woody scales (one immediately above each bract) which bear the seeds. In such a seed-bearing cone the woody

[4] Read before Section G, Botany, of the A. A. A. S., Denver meeting, August, 1901.

scales constitute the bulk of the cone, the bracts always remaining relatively small and inconspicuous. On the other hand, in the cone of a Sequoia, Taxodium, or Cupressus, the whole structure is composed of the enlarged bracts borne upon the axis. On *à priori* grounds there should be no question as to the morphological equivalence of the seed-bearing cones of pines and cypresses, and yet the added structure in the pines — the ovuliferous scale — has brought about a most uncomfortable confusion.

What is this structure? Is it a second leaf, as Robert Brown thought; a flattened axillary stem, as Schleiden thought; a single leaf of a short axillary shoot, as von Mohl suggested; or a fusion of two such leaves, as suggested by Alexander Braun, and accepted by many botanists? Is it a ligular growth as Sachs would have us believe; or is it a vestigial structure resulting from the modification and partial suppression of the axillary stem, as Celakovsky holds? This is not the place for a critical discussion of these views, but I may say in passing that they all fail to homologize the staminate and seminiferous cones.

Many years' study of the young cones of the pines has impressed me more and more with the essential identity of the cones bearing the two sexual cells, and at the same time has suggested an explanation of the origin of the ovuliferous scale which has for several years been helpful to my students. It is noticed that when the megasporangia first appear they are rounded masses of cells pushing up from the axillary region at the base of the bract of the young cone; later, this differentiates into scale and ovule. For a long time the scale portion is composed of chlorophyll-bearing parenchyma, and it is only much later that it becomes brown and woody. At all times there is no line of demarcation between scale and ovule, but the tissues are continuous and pass insensibly from one to the other. These facts led to the suggestion that the scale in the pine cone is a backward extension of the chalazal tissues of the ovules. The scale according to this view is ovular in nature, *i. e.*, it is not a new structure, but merely an enlargement and modification of a structure already present. The cones in the Cupressineae and Taxodieae are normal, *i. e.*, the megasporangia are borne by the bracts (carpels) which later become enlarged. In the Araucarieae the same structural conditions prevail, but while there is a slight backward ovular growth, the bract is still so large as to greatly overshadow it. In the Abietineae the megasporangia, which at first are secondary



BESSEY on the PINE CONE

to the bracts, soon make so great a backward (chalazal) growth as to greatly overshadow the bracts. With the enlargement of the ovular tissue there has been a decreased development of the bract. As the ovular tissue has enlarged it has assumed more and more the photosynthetic and nutritive functions elsewhere discharged by the bract (carpel), until now the latter is practically fuctionless.

Concisely stated this view may be formulated as follows: The microsporangial and megasporangial cones are strictly homologous, and in the latter the sporophyll enlarges or remains small just as the chalazal development of the megasporangium into a scale is less or more pronounced.

In accordance with this view the tribes of the family Pinaceae should be rearranged so as to place the Abietineae at the summit of the group. Probably the sequence would be something like the following:

Tribe I. CUPRESSINEAE.—With Callitris, Thuya, and Cupressus leading to Taxodieae, Juniperus leading off in a side line.

Tribe II. TAXODIEAE.—Leading through Taxodium, Sequoia, and Cunninghamia to the two tribes Araucarieae and Abietineae.

Tribe III. ARAUCARIEAE.—With Agathis lower than Araucaria.

Tribe IV. ABIETINEAE.—With Picea, Tsuga, Abies, etc., lower, and Larix, Cedrus, and Pinus higher.—CHARLES E. BESSEY, *The University of Nebraska*.

EXPLANATION OF PLATE VIII.

FIGS. 1, 2, 5, 7, are from Strasburger's *Die Coniferen und Gnetaceen*; *fig. 3* from Shaw's *Life history of Sequoia sempervirens* (BOT. GAZ. **21**: 332. 1896); *fig. 7* from Coulter and Chamberlain's *Morphology of Spermatophytes*; *fig. 4* is original. In all the figures *mg* is the megasporangium; *o. s.*, ovuliferous scale; *s*, seed; *sp*, sporophyll.

FIGS. 1, 2. *Cupressus funebris*; *1*, longitudinal section of a young megasporangial cone; *2*, longitudinal section of a seed-bearing cone, the seeds nearly mature.

FIGS. 3, 4. *Sequoia sempervirens*; *3*, vertical section of a young sporophyll and a single megasporangium; *4*, longitudinal section of a sporophyll with with seeds at maturity.

FIG. 5. *Araucaria excelsa*; longitudinal section of a young sporophyll, with seed and rudimentary ovuliferous scale.

FIGS 6, 7. *Pinus Pumilio*; *6*, longitudinal section of a young sporophyll with rudimentary megasporangium; *7*, longitudnal section of an older sporophyll, with megasporangium grown backward as an ovuliferous scale.

A. F. W. SCHIMPER.

BRIEF mention has already been made of the death of this brilliant botanist, but it is fitting to record here some of the most interesting features of his life. In view of his high rank as a botanist and his many contributions to all phases of botanical activity, it seems incredible that he was but 45 at the time of his death. His father before him, W. Ph. Schimper, had made for himself an illustrious name in botanical work, no other of his time excelling him in his two favorite fields, bryology and paleobotany. The subject of our sketch won his doctorate in 1878 at Strassburg, where his father was professor of botany.

Schimper's first famous investigation was on starch and plastids, and he was the first to show that plastids are necessary for starch formation. Another important contribution to knowledge was made when he showed that plastids do not arise spontaneously in the cytoplasm, but that they always proceed from pre-existing plastids. Some years later Schimper published papers on the formation of calcium oxalate in leaves and on the assimilation of mineral salts by green plants, calling attention to the manifold metabolic activities of the leaf, and showing that chlorophyll has a part in the production of proteids.

Botanists have often had occasion to remark Schimper's breadth of mind. Versed in all botanical fields and an investigator in many, he could scarcely be narrow. But it cannot be doubted that his extensive travels, especially in the tropical regions of both hemispheres, contributed largely to his breadth of view. American authors have often complained that continental botanists do not give sufficient credit to papers printed this side of the water, but no such complaint could rightly be made against Schimper. Perhaps his fellowship at Johns Hopkins in 1881, and his travels in Florida, the West Indies, and South America made him feel kindly toward Americans. Some years later he spent considerable time at Buitenzorg, and his investigations are among the most brilliant that have come from that famous botanical center. Only a short time before his death he accompanied the Valdivia expedition to the Antarctic regions.

In 1883 Schimper was called to the University at Bonn, where he rose from a docentship to a professorship, and it was from here that most of his investigations were published. In 1899 he accepted a call to the University at Basel, where he remained until his death, September 9, 1901. Schimper will doubtless be remembered longest through

his ecological contributions. It was he who organized and issued the *Botanische Mittheilungen aus den Tropen*, which have probably done more to give a correct picture of the ecology of the tropical vegetation than all other works combined. Schimper himself contributed the most important papers to this series, among which may be mentioned: Die epiphytische Vegetation Amerikas, in which most of our knowledge about epiphytes as they occur in tropical nature is to be found; Die Wechselbeziehungen zwischen Pflanzen und Ameisen im tropischen Amerika; Die indomalayische Strandflora. One of Schimper's most important papers was on transpiration; in this place he for the first time clearly showed that plants of cold regions and plants of saline habitats are obliged to meet the same dangers as desert plants, viz., excessive transpiration.

The crowning work of this indefatigable botanist was his *Pflanzengeographie*, which was reviewed in this journal.[5] The review written at that time was the result of a first impression. Now that almost daily use has been made of this great work in the three years since it appeared, that favorable impression has been not only fully justified but intensified. It is clear that this work marked, as then predicted, the beginning of a new epoch, an epoch that is expressed in the title: *Pflanzengeographie auf physiologischer Grundlage*. It is the physiological basis that distinguishes the new ecology from that of other days, and into this new field of endeavor Schimper led the way. It is sad indeed that those who are trying to follow out the tortuous ecological paths have lost a leader of such ability and breadth.— H. C. COWLES.

[5] BOT. GAZ. 27: 214–216. 1899.

CURRENT LITERATURE.

BOOK REVIEWS.

Medicinal plants of the Philippines.[1]

AS INDICATED in the translator's preface, the book is primarily intended to facilitate the study of the native medicinal plants by the numerous medical officers stationed at small posts throughout the Philippines, but it will also prove of great value to botanists everywhere, and particularly to pharmaceutical botanists. The style of the book is simple and very interesting, with an occasional quaint comment. For example, under tobacco, the author says, "The robust who smoke and drink to excess and meet with an accidental death on a railroad or from an acute disease that overtakes them in the midst of robust health, serve as arguments for the defenders (of the tobacco habit) to prove the innocence of the custom." And again, "The antiseptic power of tobacco is undoubted, but it is intolerable that a physician under the pretext of avoiding self-infection should enter the house of his patient and continue smoking at the bedside." As the author admits, much of the information regarding medicinal properties of plants and plant parts is obtained from the Filipino herb doctors (*curanderos*). The common native names are given. The botanical descriptions are simple and quite brief.

The book is timely, and it will assist American botanists to acquaint themselves with the flora of their new possessions.—ALBERT SCHNEIDER.

Trees in winter.

THE reviewing of so-called popular scientific books is usually unpleasant, because one has so often to say disagreeable things; but in this instance the task is quite the reverse. Miss Huntington's *Studies of trees in winter*[2] will certainly aid very materially in developing a love for nature study.

The book is unique in that it is a guide for the study of our more common trees in a season which, though popularly supposed unsuitable for a study of plants, is one that, as the book shows, has certain very marked advantages. The absence of foliage brings out much more clearly the tree habit, bark

[1] PARDO DE TAVERA, T. H.—The medicinal plants of the Philippines, translated from the Spanish into English by Jerome B. Thomas, Jr., captain and assistant surgeon, U. S. A. 8vo, pp. 269. Philadelphia: P. Blakiston, Son & Co. 1901. $2.00.

[2] ANNIE OAKES HUNTINGTON: Studies of trees in winter. 8vo, xviii + 198 pages, 75 full page half-tone illustrations and colored plates and text cuts. Boston: Knight & Millet. 1902. $2.50.

characteristics, and other details more or less obscured during the summer months. As Sargent says in his introduction to this work, "For the student of trees searching for accurate knowledge it is as important to study trees in winter as in summer." While the book has undoubted scientific value, its great value will lie in its bringing many into a little closer touch with nature.

The half-tone illustrations from actual photographs are remarkably good, bringing out details very clearly, for which no doubt the publishers deserve much credit. The colored plates, in so far as I am able to judge, are true to nature. Print, paper, and binding leave nothing to be desired.—ALBERT SCHNEIDER.

Cellulose.

IN 1895 Cross and Bevan published a large work under the title *Cellulose, an outline of the chemistry of the structural elements of plants.* Although that work was especially intended for chemists, it proved of assistance to physiologists who were concerned with this substance in its structural relations to have the chemical data brought together in a connected way. The same authors now issue a work entitled *Researches on cellulose, 1895–1900,*[3] which is intended as a supplement to the former one. It gives a brief account of those researches which have been published between the dates named, as well as certain of the authors' own investigations not previously published. No attempt has been made to give the subject-matter the form of a connected record. The papers are presented in abstracts, some very brief, some much longer, but all without comment. The book serves well to show the direction in which investigation is proceeding, and also the advances made in technical application of chemical knowledge. It would be well for botanists to familiarize themselves more thoroughly with the chemistry of cellulose. We should then hear less about the cell wall being "composed of cellulose," which, from a chemical point of view, tells as little about it as to say that a house is built of stone tells of its materials or its architecture. The investigations into the cellulose of fungi, the hemicelluloses, lignocelluloses, and pecto-celluloses are contributions to plant physiology as well as to chemistry. In spite of its technical character the book is one which botanical libraries should have.—C. R. B.

NOTES FOR STUDENTS.

V. K. CHESNUT[4] has published a very full account of the plants used by the Indians of Mendocino county, California. The numbers of plants used, and the uses to which they were put, are amazing to those not familiar with the subject.—J. M. C.

[3] CROSS, C. F. and BEVAN, E. J.: Researches on cellulose, 1895–1900. 8vo, pp. xii + 180. London, New York, and Bombay: Longmans, Green, and Company. 1901.

[4] Contrib. U. S. Nat. Herb. **7**: 295–408. *pls. 10–21.* 1902.

A CONTRIBUTION from the Leipzig Institut on the function of hydathodes[5] comes to these conclusions: (1) they are not necessary to the plant for the prevention of the injection of the intercellular spaces, since plants do not suffer from injection (though *Impatiens parviflora* sheds a large part of its leaves); (2) they do not render the plant important service in the acquisition of mineral food by hastening the movement of water, for Pfeffer's *Physiology* says that even in the moist climate of the tropics transpiration keeps the leaves supplied! "We may therefore regard the hydathodes only as organs whose presence is now occasioned less by their necessity than by heredity." Since when? — E. B. COPELAND.

N. SCHULZ,[6] in investigating the relations of light to the germination of the spores of mosses, ferns, and equisetums, has reached the following conclusions: (1) these spores germinate only in light; (2) an exception to this rule occurs only in certain ferns that have other biological peculiarities, as ophioglossums, etc.; (3) light is necessary to spores of mosses and ferns as a stimulus to the transformation of the food reserve and to growth; (4) other stimuli cannot replace light in this process except in Ceratopteris, where it may be replaced by raised temperature; (5) in a sugar solution moss spores seem to germinate, but this growth, accompanied by stronger storage of starch and the prominent swelling of the spore, cannot be compared with germination under normal conditions; (6) the spores of equisetums produce cells that are not in resting condition and contain no food, and hence light is not necessary as a stimulus to digestion, but as a condition for photosynthesis. — F. M. LYON.

BLACKMAN AND MATTHAEI[7] have been observing the responses of certain leaves to traumatic stimulation. The leaves of *Prunus Laurocerasus* show remarkable vitality when removed from the plant, remaining fresh for more than a month, while oleander leaves remain fresh for several months, and even put forth roots if placed in water. Portions of old Prunus leaves were killed, and these patches of dead tissue were soon found to be cut off by an absciss layer and exfoliated. The absciss layer involves epidermis and mesophyll, and after exfoliation has occurred cutinization of the exposed parts takes place. When a number of wounds were made close together, a general abscis layer developed around all of these, and live parts as well as dead were exfoliated. In young leaves actual regeneration of new tissues, in distinction to the healing processes just noted, was observed. The authors discuss wound cork and other regeneration tissues, agreeing with Massart and others that suberization is due chiefly to a dry atmosphere. — H. C. COWLES.

[5] LEPESCHKIN, W.: Die Bedeutung der Wasserabsondernen Organe für die Pflanzen. Flora **90**: 42–60. 1902.

[6] Beihefte Bot. Centralb. **11**: 81–97. 1901.

[7] Annals of Botany **15**: 533–546. 1901.

O. ROSENBERG,[8] in investigating the pollen of *Zostera marina*, finds that the radially elongated archesporial cells give rise to tapetum on both sides of the sporangium by cutting off isodiametric cells at each end. Some of the primary sporogenous cells form sterile tissue. This is nourishing in nature and is later represented only by free nuclei between the spore mother cells. The long primary sporogenous cells destined to form microspores divide many times by longitudinal walls forming linear pollen mother cells. The tetrad divisions following are also longitudinal, and the second occur before the walls of the first reach the ends of the cells. The nature of these divisions is evidenced by their rapid succession and by the reduction of chromosomes from twelve to six. The remarkable thread-like form of the pollen (2000 by 8μ when mature) prevents the formation of the typical tetrad group, the microspores simply adhering in bundles. The solution of the microspore problem in Zostera is of special interest to morphologists since it clears away the last reported case of the formation of microspores from mother cells without the reduction division.—T. C. FRYE.

NELUMBO is certainly a perplexing form. The closed bundles, irregularly scattered, present a distinctly monocotyl feature; the leaves with reticulate venation suggest dicotyls, while the flowers might be either monocotyl or dicotyl. The earlier observers, dealing with mature seeds, have described the embryos of *Nelumbo* and of other members of the Nymphaeaceae as dicotyledonous. The recent work of Mr. H. L. Lyon[9] seeks to establish their monocotyledonous character. Material for the present work was collected in August, 1899, and August, 1900, in southeastern Minnesota, where acres of *Nelumbo lutea* grow in the bayous of the Mississippi river. A study of the development of the embryo shows that it retains a spherical shape until it consists of several hundred cells. The single cotyledon then appears as a crescent shaped organ partly surrounding the plumule. The cotyledon now becomes bilobed by a localization of growth. The first foliage leaf arises on the side opposite the cotyledon. The radicle is transitory and does not develop into a primary root, but the work is done by secondary roots arising from the hypocotyl. The only character which has kept the Nymphaeaceae among the dicotyls is the apparently dicotyl embryo. Since study of its development shows that the embryo is truly monocotyledonous, and since the anatomy conforms more closely to the monocotyls, Mr. Lyons refers the Nymphaeaceae to a subseries coordinate with the Potamogetonaceae, Alismaceae, and Butomaceae in the series Helobiae. A future paper will deal with the development of the embryo-sac and fertilization.—CHARLES J. CHAMBERLAIN.

[8] Ueber die Pollenbildung von Zostera. Meddel. Stockholms Högsk. Bot. Inst., pp. 21. 1901.

[9] LYON, H. L.: Observations on the embryogeny of Nelumbo. Minnesota Bot. Studies 2:643–655. 1901.

IT has long been known that the internal osmotic pressure of fungus hyphae is much greater when these are grown in concentrated solutions than when the medium is dilute. The question whether this is due to an absorption of the osmotically active substance of the surrounding medium or to an active secretion of other solutes into the cell sap has been taken up again by von Mayenburg.[10] That the internal pressure does not rise by mere inward diffusion of the surrounding solute, at least in most cases, was shown by Eschenhagen, and the present author (who uses *Aspergillus niger*) has corroborated this result by analyses of the fungus body. But in the case of glycerin there is an exception to this rule, as might be expected from the great power of this substance to penetrate most protoplasts. Fungi grown in concentrated glycerin solutions are found to contain this compound in about the same concentration as it occurs in the surrounding medium.

An attempt was made to determine the nature of the internally active substances in the more usual cases, where inward diffusion plays no important part in the rise of turgor pressure. Mineral salts and potassium salts of organic acids are shown to be unimportant in this regard. The author was unable to identify the active substance, but presents evidence which leads him to suggest that it may be some oxidation product of dextrose.

The author suggests that there may be a parallelism between the effects produced by mechanical checking of growth (in higher plants) and those caused by concentrated medium. Both agencies decrease growth and both are accompanied by rise in internal osmotic pressure.— B. E. LIVINGSTON.

SEVERAL valuable contributions to our knowledge of the process of fertilization have been recently made by Hans Winkler.[11] By an ingenious method this author was able to separate mature unfertilized eggs of the brown alga, *Cystosira barbata*, into two parts, the one nucleate, the other non-nucleate. He observed that sperms penetrate both parts, and that after their entrance both parts divide and produce normal embryos. Cell division, however, is somewhat more rapid when the female nucleus is present.

Winkler was also able to corroborate Morgan's observation that non-nucleate portions of the eggs of the sea urchin, *Echinus microtuberculatus*, will produce normal embryos after the entrance of sperms. The observation is carried further, however. If a non-nucleate portion be cut from an entire normally fertilized egg, this portion may be made to develop a normal embryo by a second fertilization. The experiment no longer succeeds, however, after the first cleavage plane has been formed.

Unfertilized eggs of *Arbacia pustulosa* were made to develop, at least as far

[10] MAYENBURG, OTTOMAR HEINSIUS VON: Lösungs-concentration und Turgorregulation bei den Schimmelpilzen. Jahrb. wiss. Bot. **36**: 381–420. 1901.

[11] WINKLER, HANS: Ueber Merogonie und Befruchtung. Jahrb. wiss. Bot. **36**: 753–775. 1901.

as the 16-celled stage, by placing them in an extract of the sperms of the same species. The sperms were extracted both in distilled water and in concentrated sea-water, at a temperature of 70°, which is fatal to them. The extract was brought nearly to the concentration of normal sea-water (by the addition of concentrated sea-water or of distilled water, as the case demanded), and the unfertilized eggs were placed therein. The extract as used had a somewhat higher osmotic pressure than that of normal sea-water, but the author shows that this is not a fatal objection to his experiments, since the same concentration of KNO_3, $MgCl_2$, etc., produced no response in the eggs. Neither did a similar extract made from the sperms of another species have any effect. What is the nature of the chemically active body here demonstrated, the author cannot yet say. He closes the paper with some remarks upon the theory of fertilization.— B. E. LIVINGSTON.

ZACHARIAS[12] has recently made another contribution to the knowledge of sexual cells. Chemical and morphological researches upon the sperm cells of animals and plants indicate that the cilia and spiral bands of plant sperms correspond respectively to the tail and head of animal spermatozoa. The spiral band and the head are distinguished chemically by their nuclein content, nuclein being lacking in the cilia and in the tail. Besides many animal forms, the author investigated the sperms of Nitella, Chara, Ceratopteris, Pellia, Polytrichum, and other plants. The various forms were treated with a solution of sodium sulfate (sodium sulfate 10 gr., acetic acid 1 gr., water 100 gr.). To this solution a little acid fuchsin was added. This sharply differentiates the nuclein-containing portion from that which contains no nuclein, and shows that heads and spiral bands differ in their chemical behavior from tails and cilia. When solution with methyl green instead of acid fuchsin is applied to spermatozoa of the salmon, the head, which contains the nuclein, becomes swollen, while the tail and middle piece become sharply differentiated but do not stain. The tail and middle piece, however, stain well when acid fuchsin is used. When alcoholic material of the spermatozoa of Triton is treated with the fuchsin-containing solution, the tail and middle piece are not at all swollen but become stained, the latter very intensely. The head appears swollen and slightly stained, but the staining may be due to a delicate covering and not to the nuclein-containing content of the head. Living sperms of Chara and Nitella show the anterior and posterior portions of the band not at all swollen but intensely stained, while the middle portion is not at all stained but is very much swollen. Zacharias was able to satisfy himself that the middle piece of Triton and the salmon, as well as the blepharoplasts of Chara and Nitella, contain no nuclein. The term "middle piece" is variously used, but only when it is of centrosome

[12] ZACHARIAS, E.: Beiträge zur Kenntniss der Sexualzellen. Ber. d. deutsch. bot. Gesell. **19**: 377–396. 1901.

origin is it to be compared with the blepharoplasts of plants. In some cases he was able to determine that the portion of the male sexual cell which is derived from the nucleus of the mother cell contains a larger percentage of nuclein than the nucleus of the female sexual cell. The investigations of botanists and zoologists have not yet determined the nature of the influence that the sperm exerts upon the egg in normal fertilization, but evidence is accumulating, and the present paper adds some interesting facts in regard to the chemical behavior of the sperm cells of animals and plants.—CHARLES J. CHAMBERLAIN.

ARNOLDI[13] has made another contribution to our knowledge of morphology of gymnosperms. The previous papers of the series have already been reviewed in the GAZETTE. The present paper deals with Sequoia and other members of the Sequoiaceae, namely Taxodium, Cryptomeria, Cunninghamia, Arthrotaxis, Glyptostrobus, and Sciadopitys. As might be expected, in a paper dealing with so many and such inaccessible genera, the series are often incomplete, but the results are nevertheless interesting and important. In *Cunninghamia sinensis* there are numerous archesporial cells and several embryo sacs attain a considerable degree of development. In *Sequoia gigantea* the endosperm develops uniformly, thus differing decidedly from *S. sempervirens*, in which the development at the middle of the endosperm differs from that at both ends. The archegonia occur singly or in groups, but are not so numerous as in *S. sempervirens*. There are two neck cells and no ventral canal cell. In Taxodium, Cryptomeria, and Cunninghamia the archegonia are grouped as in the Cupressineae, and have a common jacket, but sometimes there is a layer of endosperm between the archegonia. In Sciadopitys the neck is very peculiar, consisting of from four to eight vertically elongated cells. Proteid vacuoles are present in the archegonium and they probably arise from the jacket cells. These vacuoles are not found in any other members of the Sequoiaceae. No ventral canal cell was identified, but it may yet be found. In Cryptomeria the upper end of the egg becomes mucilaginous, and sometimes separates from the rest of the egg, but no ventral canal cell is formed.

In *Sequoia sempervirens* at the time of fertilization the pollen tube contains two male cells and two free nuclei, one the nucleus of the pollen tube, and the other the nucleus of a disorganized cell which Belajeff called the sterile cell of the generative complex. No vegetative cell of the male prothallium is formed. The body cell contains starch. In *S. gigantea* the pollen tube presses between the endosperm and the nucellus. The pollen tubes of Taxodium and Cryptomeria behave as in the Cupressineae. The

[13] ARNOLDI, W.: Beiträge zur Morphologie einiger Gymnospermen. V. Weitere Untersuchungen der Embryogenie in der Familie der Sequoiaceen. Bull. des. Nat. de Moscow, pp. 1–28. *pls.* 7–8. 1901.

upper part of the egg becomes mucilaginous and presses upon the neck cells from beneath, while an outgrowth from the pollen tube presses from above and forces its way into the egg. In *Sequoia sempervirens* the round male cell becomes elongated, one figure showing it spirally wound, but this may not be the normal form. In Taxodium, however, the spiral form is the usual one, and this is probably the case in Cupressineae also. The form is probably due to the narrow entrance, the male cell having a greater diameter than the neck of the archegonium. The behavior of the chromatin during fertilization is not described.

In *Sequoia sempervirens* the sex nuclei fuse at the middle of the archegonium, then sink to the bottom and divide. Two cells are organized about the nuclei, and the lower nucleus divides again, thus giving rise to a row of three cells, the lowest of which becomes the embryo, and the middle the suspensor. The upper soon disorganizes, and at this stage the embryo appears to consist of two cells. The first division of the embryo is longitudinal. In Cryptomeria and Taxodium the fertilized egg nucleus passes to the base of the archegonium where two or three divisions occur. Cells are formed about the lower nuclei, but the upper ones remain free. Two or three tiers are organized, the lower one or two tiers forming the embryo, and the tier next above the suspensor.

This agrees with Strasburger's account of Juniperus, except that the free cells were not described. Cunninghamia agrees with Taxodium, Cryptomeria, and the Cupressineae. In Sciadopitys the series was very incomplete but enough was obtained to show that the embryology is very peculiar. The earliest stage found shows four free nuclei at the base of the archegonium, as in all the Abietineae. A later stage shows a "rosette," suspensors, and a loose tissue of embryonic cells. The lowest of these cells form the embryo, those next above develop into a second set of suspensors, still leaving some of the embryonic cells between the two suspensor systems. The figures bear some resemblance to Strasburger's figures of Araucaria, but in Strasburger's account the second set of suspensors, as described by Arnoldi, form a cap which is cast off, while the part between the two suspensor systems — or between the suspensor and cap — develops into the embryo. Arnoldi believes that the two species of Sequoia should constitute a family, the Sequoiaceae; that Taxodium, Cryptomeria, and perhaps Cunninghamia should be included in the Cupressineae; and that Sciadopitys is best regarded as constituting a special family, the Sciadopitaceae. — CHARLES J. CHAMBERLAIN.

D. H. SCOTT[14] has published a detailed account of the remarkable fossil

[14] On the structure and affinities of fossil plants from the paleozoic rocks. IV. The seed-like fructification of Lepidocarpon, a genus of lycopodiaceous cones from the carboniferous formation. Phil. Trans. Roy. Soc. B. **194**: 291–333. *pls. 38–43.* 1901.

Lepidocarpon, of which a preliminary announcement was made in this journal.[15] In 1897 Mr. J. Lomax found in the lower coal measures as trobilus that differed from those of the genus Lepidostrobus in that each megasporangium contained a single large functional megaspore and three aborted ones. No other Selaginella-like fossil had been discovered with fewer than four megaspores of equal size in a sporangium. Moreover, in the same block of stone were found many detached sporangia and sporophylls identical with those of the strobilus, interspersed with seed-like bodies clearly referable to the *Cardiocarpon anomalum* of Williamson. The latter structures differed from the megasporangia of the cone in possessing an integument and a slit-like micropyle. The conclusion suggested itself to Scott and others that Williamson may have been mistaken in identifying the structures as gymnosperm seeds, but on the evidence in hand it was impossible to refer them to a lycopod. In January 1900, Mr. J. Wild found a lycopod cone that settled the matter beyond question. The upper portion of this strobilus bears sporangia identical with those attached to the cone discovered by Lomax. The basal sporangia, however, are invested by an integument with micropyle, and in all respects agree with the organisms described by Williamson as the "seeds" of Cardiocarpon. In addition to the strobili mentioned, fragments and many detached sporangia have been found, enabling the author to give convincing proof that certain of the highest cryptogams bore seeds. In order that this fossil may not be confused with the Selaginella allies having non-tegumented sporangia, the Lepidostrobi, Scott established the genus *Lepidocarpon* to contain these lycopod "seeds."

A very full description of this interesting organism is given. The sporangia are described as elongated sac-like structures, attached by one surface to the sporophyll. The integument consists of a cushion-like upgrowth arising from the upper face of the pedicel of the sporophyll, enclosing the sporangium completely, except for a long slit running its full length. The sporangium wall is like that of Lepidostrobus, but the megaspore wall is said to be much thinner than that of a spore destined to be shed. It is membranaceous in character, but displays reticulations, characters between those of an embryo sac and a shed megaspore. In several instances prothalli quite comparable in structure to those of Isoetes or Selaginella were found. Archegonia could not be identified with certainty. One section of a prothallus displays cells of quite different form occupying the central region. The author tentatively suggests that they may belong to an embryo. This seems highly probable to the reviewer, who has many similar sections of *Selaginella rupestris*, which also is known to bear "seeds." The elongated cells correspond closely to the vascular bundle in its nascent stage, and the group of smaller cells near the apex of the prothallus to the

[15] BOT. GAZ. 31: 279. 1901.

cross section of the young root. The dark cell at the right in his *fig. 23* is in a position with reference to the embryo that corresponds to the archegonium out of which it has grown. The section of the fossil shows no suspensor, but in *Selaginella rupestris* these cells are often difficult to distinguish from those of the surrounding gametophyte. It is interesting to note that the transitional stages between completely tegumented and non-tegumented "seeds" have not been found. Scott suggests that the non-tegumented sporangia may be arrested organisms rather than younger normal stages. This view accords with Bower's recent studies of the sporangia of Selaginella. However, as detached sporangia are not uncommon in the region explored by Messrs. Wild and Lomax, more light may be shed upon them by later study.

The points of likeness between a seed of a spermatophyte and that of a higher cryptogam are (1) the possession of an integument with a micropyle; (2) a single functional megaspore; (3) the retention of the megaspore, involving (4) the detachment of the seedlike organ as a whole and its indehiscent character. The essential distinction between the higher cryptogams and spermatophytes lies in the fact that in the latter pollination takes place on the parent plant. This point has been settled lately in three living species of Selaginella, but in the case of Lepidocarpon no satisfactory evidence has been found. No microspores have been found between the gaping valves of the integument. It may be that Lepidocarpon should be regarded as a seed in a nascent stage of evolution, and that pollination occurred as in the lower cryptogams after the spores were shed. It is the opinion of the author that this discovery in no way affects views held by him previously that the gymnosperms are of filicineous origin, and that their seeds differ too much in detail from those of the lycopods to warrant affinity. Nor does he think any light is thrown hereby upon the origin of the angiosperms. He regards Lepidocarpon as representing a branch of the phylogenetic tree parallel to or perhaps convergent with the spermatophytic phylum, but without genetic connection with it.—FLORENCE M. LYON.

NEWS.

DR. BÜSGEN has been called to a professorship in botany at the Forest Academy in Münden.

SCIENCE for January 17 contains an interesting exposition of the very unfortunate forestry situation in New York.

DR. SÁNDOR MÁGÓCSY-DIETZ has been called to a professorship in plant morphology and physiology in the Hungarian University at Budapest.

MR. W. W. BAILEY, of Brown University, has been elected president of the Rhode Island Horticultural Society for 1902. He is also botanist to this society.

THE MACMILLAN CO. announce that they are about to publish a *University text-book of botany* by Douglas H. Campbell of Leland Stanford University.

DR. D. T. MACDOUGAL has gone to Arizona and Sonora to get cacti and other xerophytes for the new greenhouses in the New York Botanical Garden.

PROFESSOR JOHN MACFARLANE and a party of students from the University of Pennsylvania spent the Christmas holidays in botanical field work in Florida.

M. R. A. PHILIPPI has been elected director of L'Académie Internationale de Géographie Botanique for 1902. The current bulletin of this organization gives a list of members with their addresses.

THE COMMITTEE appointed by chairman Forbes to consider and report to the Naturalists of the Central States a plan for organization includes as its botanical members Drs. William Trelease and John M. Coulter.

THE SEVENTH annual meeting of the Vermont Botanical Club was held at Burlington, January 24 and 25. Dr. B. L. Robinson, of Harvard University, addressed the club on "Some recent advances in the classification of flowering plants."

BEGINNING with the January number, *The Forester* has been merged with *National Irrigation*. The combined journal is entitled *Forestry and Irrigation*. The new journal is to contain more pages than *The Forester* and is to be more fully illustrated.

RECENT NUMBERS of *Plant World* and the *Journal* of the New York Botanical Garden contain pleas for the preservation of our native plants,

and announce a gift of $3,000 by the Misses Olivia and Caroline Phelps Stokes to further this desirable end.

IN THE *Journal* of the New York Botanical Garden for January there is an account of the research work in the Garden. The paleobotanical library and collections have been tranferred from Columbia University to the Garden and Dr. Arthur Hollick appointed curator.

PROFESSOR W. F. GANONG has just brought to completion a new laboratory and greenhouse for physiology on the lines of those recommended in his recent laboratory manual. The house is very thoroughly built, and equipped to meet the needs of elementary instruction.

A NEW botanical periodical is announced from Ceylon, *The Annals of the Royal Botanic Gardens, Peradeniya*. This journal will deal with pure and applied botany, particularly in connection with the Ceylon gardens. Exchanges with scientific journals will be made with pleasure.

PROFESSOR JOHN GIFFORD, of the College of Forestry of Cornell University, and Professor W. W. Rowlee, of the botanical department of Cornell University, spent the Christmas vacation in Cuba and the Isle of Pines. They secured a fine set of photographs and considerable herbarium material.

IN *Nature* for January 2 there appears an interesting sketch of the life of Sir J. Henry Gilbert, who died on December 23, at the age of 84. The deceased was best known in connection with the Rothamsted experimental investigations, which have been of great value to the agricultural world.

THOMAS MEEHAN & SONS, the well-known nurserymen of Philadelphia, have established for their employees an evening school of botany with a systematic course of study, under the direct care of Mr. S. M. Meehan, a member of the firm, and Mr. Ernest Hemming, who has charge of the department of herbaceous plants.

THE ANNOUNCEMENT is made of a new geographic periodical, the *Journal of Geography*, to take the place of the *Journal of School Geography*, and the *Bulletin of the American Bureau of Geography*. The new magazine will have a special department of phytogeography in charge of Dr. Henry C. Cowles, of the University of Chicago. Considerable attention also is to be given to economic botany.

FASCICLE 1 of the *Ohio fungi exsiccati*, containing sixteen numbers, has recently been issued by Dr. W. A. Kellerman of the State University at Columbus. In addition to the usual data, the label contains a reprint of the original description, with citation of the place of publication. This is intended to be helpful especially to students whose library facilities are deficient. The specimens are pronounced of fine quality.

AT THE holiday meeting of the Society for Plant Morphology and Physiology, the following officers were elected: President, Volney M. Spalding,

University of Michigan; Vice-President, Byron D. Halsted, Rutgers College; Secretary-Treasurer, W. F. Ganong, Smith College. The names of Professors C. E. Bessey and W. F. Ganong were suggested to the American members of the Association Internationale des Botanistes for election as members of the general committee when this election is held.

THE COLONIAL MUSEUM of Harlem proposes to commemorate, on June 15, 1902, the 200th anniversary of the death of Georg Eberhard Rumphius, who studied the botany of the island of Amboina, one of the Moluccas, for many years. Arrangements have been made to issue a medal which shall bear on one side a picture of Rumphius, and on the other a view of Amboina. It will be 50 mm in diameter, and can be obtained in silver for 25 florins or in bronze for 5 florins. It is also proposed to issue a memorial volume.

DR. EDWARD PALMER, the veteran explorer of Mexico, left Washington January 15 for a collecting expedition in the province of Santiago, Cuba. He will obtain the usual number of sets, which will be offered for sale upon his return. Dr. Palmer will be accompanied by Mr. Charles Louis Pollard and Mr. William Palmer, both of the United States National Museum, who will collect plants, mammals, birds, and reptiles for that institution. As the party will pay especial attention to the unexplored mountains in the southern portion of the province it is expected that the scientific results will be considerable.

AN INDEX to volumes I–X of the *Annals of Botany* (1887–96), prepared by T. G. Hill under the direction of the editors, is announced as ready. In preparing it the aim has been to include, in addition to titles and authors' names, the principal subjects dealt with in each paper, including names of all new species, all species which are described, their synonyms so far as they occur in the *Annals*, and all species as to which original observations are recorded. On the other hand, species which are not new, and which are merely mentioned or enumerated without any description or observation being recorded, are omitted. Those who have lamented the absence of an index will welcome this. It will doubtless prove useful, but is liable to be too limited. We have been hoping that the editors would supply a complete index with each volume.

TOM VON POST and OTTO KUNTZE propose the publication of a *Lexicon Generum Phanerogamarum* in which they intend to supply (1) information as to the legal and scientifically correct nomenclature of genera; (2) nomenclatural revision of sub-genera, families, sub-families, and higher groups according to the international code; (3) correct citation of authors since 1737; (4) correct modes of writing names and citations; (5) the most complete list of all single names of genera, both valid names and synonyms; (6) in the second part a numbered systematic list of valid genera which may serve for the arrangement of herbaria; (7) with each valid genus name the number of

species, their geographic distribution, and the sub-genera; (8) the names of fossil genera corrected according to the law of priority; (9) as an appendix, a list of names of cryptogams heretofore altered in accordance with the law of priority.

UNDER the pressure of increased demands upon its space the *Centralblatt für Bakteriologie, Parasitenkunde, und Infektionskrankheiten* has been enlarged and is issued in somewhat altered form. Part I, containing original contributions, will be published in numbers of varying sizes, to avoid dividing a paper, a volume being composed of fifty signatures. The abstracts will be issued in separate weekly numbers of about two signatures. Part II, which embraces chemical and technological bacteriology, instead of being issued fortnightly as heretofore, will also be published weekly in numbers containing two signatures, the form being unchanged. Particular importance hereafter will be attached to the summary reviews of the state of knowledge regarding certain special subjects. Reports from scientific societies and communications from bacteriological institutes will be a feature of the proposed improvement.

THE FIRST number of the *Botanisches Centralblatt* under the new control has been received. M. Bornet discusses the aim of the Association Internationale des Botanistes; the secretary and editor-in-chief, Dr. J. P. Lotsy, gives the history of the new association, with lists of the members and of the special editors. The journal appears in new typographical dress, which notably improves it. With the vigorous editorial boards in various countries, the reviews promise to be more complete and satisfactory than ever before. The *Centralblatt* is commended to the cordial support of American botanists, who are asked to cooperate with the American editorial board by sending promptly to the proper member copies of their publications. A list of the American editors, with the special field of each, was published in our January number. In the list of members of the Association Internationale des Botanistes the United States already leads other countries. Membership in this association, which costs 15 florins ($6.25) entitles one to receive the *Centralblatt* free. To members of the association only, a complete set of the *Centralblatt* is offered at the extremely low price of $36, instead of the original price of $108; certain odd volumes can also be supplied at 50 cents per volume.

FROM ADVANCE SHEETS of the annual report (for 1901) of the Missouri Botanical Garden it appears that although the extreme heat and prolonged drouth of the summer made gardening operations extremely difficult, the losses in the garden were comparatively small; however, further deaths among the trees are to be expected, unless the precipitation during the winter and spring far exceeds the average. 773 new plants were brought into cultivation, making a total of 9,967. 2,948 plants were distributed to hospitals and

schools. An active exchange has been maintained with other botanical establishments. 91,262 persons visited the garden, which was approximately 20,000 more than in any previous year. On each of the only two Sunday afternoons during which the garden is open about 20,000 persons visited it, the visitors on these two days amounting to 45 per cent. of the total number for the year. 16,256 sheets of specimens were added to the herbarium; nearly 7,000 by gift or exchange, 5,544 by purchase. The number of specimens now in the herbarium is estimated at about 365,000. The additions to the library number 929 books, and 254 pamphlets, making a total of 36,000. 1,184 serials are received at the library, of which 101 are purchased and the remainder, issued by 643 institutions, are presented or received in exchange. The gross receipts of the garden were $125,690.73, of which $44,409 were spent for maintenance and improvement of the garden itself.

THE *Comptes Rendus* for December 16 contains the annual announcement of prizes. The strictly botanical prizes have been awarded as follows: The Prix Bordin to Matruchot and Molliard for their work on the action of freezing and the lack of oxygen on cells, and for physiological work on Stichococcus; the Prix Desmazières to Hirn for his "Monographie et Iconographie des Oedogoniacées;" the Prix Montagne to Mazé for his work on the organism of legume tubercles; the Prix de La Fons-Mélicocq to the late Ferdinand Debray for his work on the algae of northern France; the Prix Thore to Patouillard for his taxonomic work on Hymenomycetes. The Prix Gay in physical geography was divided between Franchet and Saint-Yves for their work on the distribution of alpine plants. The Prix Montyon in physiology was awarded to Mirande for his anatomical and physiological studies on the Cuscutaceae.

Among the prizes and subjects for the coming year are the following: the Grand Prix des Sciences Physique for the best work on the formation and development of the egg in Ascomycetes and Basidiomycetes; the Prix Bordin for the best general treatment of double fertilization in the entire group of angiosperms; the Prix Desmazières, open to everybody, for the best treatise on cryptogams; the Prix Montagne for researches on the lower cryptogams.